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GREAT BRIDGE OVER THE RED RIVER IN INDO-CHINA.

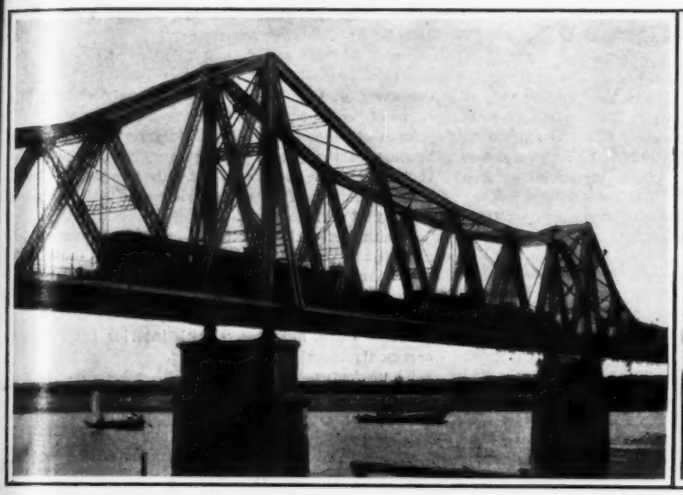
An enterprise of considerable scope in the French provinces of the Extreme Orient is the new railroad line known as the Yunnan system. The already existing railroad, in the region of Tonkin in Indo-China, will be further extended by an addition which is somewhat more than its present length, and is to run across the frontier and through Chinese territory. The two branches of railroad constitute a continuous line somewhat over 500 miles in length. At present the Haiphong-Hanoi-haokai railroad extends from the coast through the important center of Hanoi and thence to the Chinese frontier, continuing from this point by the new section of line which is now in construction. One of the most important features of the new road is the great bridge erected across the Red River, which has a total length between abutments of 5,544 feet, and thus ranks as one of the longest railroad bridges in the Old World. The Red River, even at the seasons of low water, is of a considerable width, and during the high-water periods this width is very much increased; hence the need for the above unusual length. By reason of the freshets which occur in this river and are quite noteworthy, special precautions were required in bridge building at this point. The work could only be carried out during the period extending from October to May, and work had to be stopped entirely during the rest of the year owing to the freshets which cover this period.

The present construction is known as the Doumer Bridge, being so called from the former Governor-General of Indo-China. It is of the cantilever type, this being found to be the best adapted for the prevailing conditions in the Red River. The contract for the work was given to the Daydé and Pillé firm.

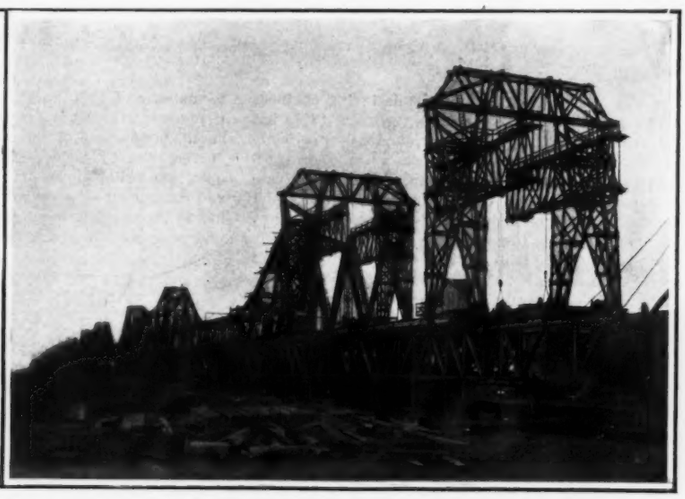
The bridge contains 19 spans. It consists of a series of cantilevers, supporting parallel trusses 248 feet in length. The alternate spans, measured between centers of piers, are respectively 350 and 429 feet in length. The depth of the cantilevers above the piers is 56 feet; at the point of junction with the suspended trusses the height decreases 20 feet.

The main platform of the bridge is used for the railroad track; and at each side there is a 4-foot 6-inch footway which is supported by a bracket construction lying outside of the main part of the bridge. The railroad rails are laid on longitudinal timbers and are provided with compensators so as to allow for expansion of the rails. There are ten such devices along the whole length of the bridge, and they are regulated for a range of 70 deg. C. As to the straight trusses, they have a length of 168 feet 4 inches, a uniform height of 20 feet, and a rectangular section. As to the width, the main beams of the bridge have 15 feet 10 inches between centers, leaving an inner space of 13 feet, while at the outside is the footway mentioned above. The total width of the bridge between outside railings is 26 feet 5 inches.

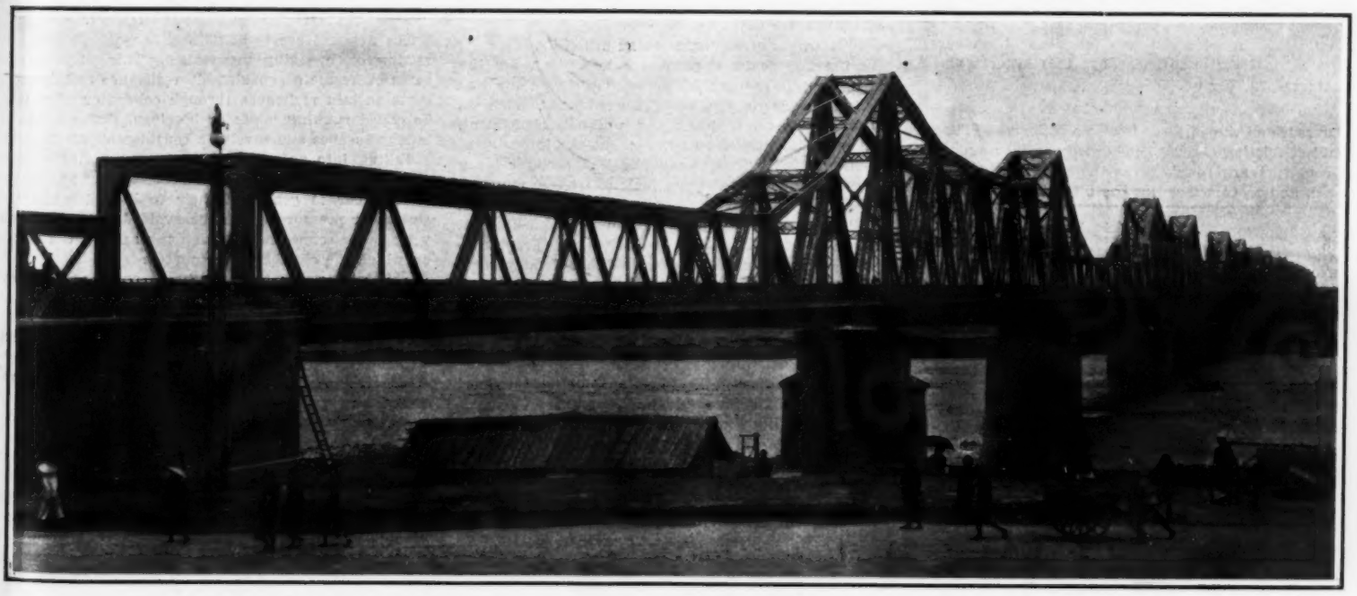
The bridge is carried on 18 piers, and they were built by the compressed air metallic caisson system, going down to a hard bearing at a depth of 108 feet 2 inches below low-water level. At the base the piers have a rectangular area of 23 feet 5 inches by 14 feet 5 inches, terminating in a semicircular section at the ends. This section prevails in the pier for some dis-



ONE OF THE CANTILEVERS.



VIEW SHOWING THE ERECTING GANTRYS.



THIS FINE STRUCTURE, BUILT BY FRENCH ENGINEERS, CONTAINS 19 SPANS AND HAS A TOTAL LENGTH OF 5,544 FEET.

THE GREAT CANTILEVER RAILROAD BRIDGE OVER THE RED RIVER, INDO-CHINA.

tance above water level, but it is diminished at a point near the bridge structure, and at this point it has a rectangular section of somewhat smaller dimensions. From bottom to top the height of the pier is very near 140 feet.

The great rise in the river of 26 feet and its velocity of 13 feet per second, which occurs between June and November, was, as we already mentioned, an obstacle in the construction of the bridge. Under these conditions the work had to be arranged so that it could be rapidly carried forward during the low-water periods and entirely suspended for the rest of the year. Another point is that during the high-water periods a great number of timber rafts, 500 feet in length, pass down the river, so that the piers must be protected from damage during this period in the intervals when work is being carried on. During the working season from November to June the construction had to be therefore pushed as rapidly as possible, and for this purpose there were employed between 2,000 and 3,000 native workmen, who were directed by 40 engineers or foremen. In the construction work of the piers by means of the caissons, the working range extended for a length of over half a mile at a time. An extensive plant had been erected on shore which included all the machine shops necessary for the work, besides an electric plant, so that the whole of the bridge work could be provided with electric light. The caissons for the 18 piers and the two abutments were all sunk in two seasons from October to May in each case, and this will give an idea of the rapidity of the work. It is also to be remarked that all the native labor employed on the bridge was previously untrained.

The method used in the mounting of the steel work of the bridge by means of scaffoldings will be remarked in our engravings, one of which shows the bridge as it is nearing completion. As this work had to be carried on rapidly during the available period of the year, the construction firm made use of a movable scaffolding under the bridge, which left a space of 80 feet in the river for navigation. When one part of the construction was finished, the scaffolding was advanced to the forward part of the work. For the upper part of the work there were used the large erecting gantrys, shown in the engravings. In the present bridge the total weight of the steel work is 5,700 tons, and there was used in all 2,225,000 cubic feet of masonry for the piers and abutments.

FRICTION CLUTCHES.*

THEIR PRINCIPLES OF DESIGN.

BY J. RICHARDS.

IN a late letter from an eminent designing engineer in England, there is the following remark: "I do not like friction clutches and never, under any circumstances, embody them in a design, when their functions can be attained by other means." This I conceive to be a common opinion among engineers and mechanics, and considering the many very useful functions performed by these clutches, it is certainly time to proceed to some analysis of the matter, to find out wherein the faults lie.

Beginning generically, so to speak, their purpose is to transmit power and motion by tractile force or friction, as has been done for centuries by bands in a very satisfactory manner, the conditions of operating being much the same, or nearly the same—the main distinction being that in stopping and starting the cumulative tractile force is in the case of bands attained by the extent of "area" in contact, and in the case of clutches by the amount of pressure between the tractile surfaces. This proposition, being one of fact, needs no discussion; but out of this fact comes a corollary of much significance—the key, in fact, to the impediments and bad reputation of friction clutches.

In these, of whatever kind, the engagement and the tractile force exerted are both functions of pressure; so, also, is their endurance; but this latter will be considered further on.

PRESSURE AND ENDURANCE.

Pressure on the surfaces is also a commercial "exponent" of friction clutches. Their dimensions and cost to construct are inversely as the pressure to be endured, and in this fact lies the incentive to high and destructive pressures. A small clutch—one of 18 inches diameter, for example—capable of transmitting 50 horse-power, is apt to be regarded as a wonderfully efficient implement, and so it is; but it carries on its face the mark of its own destruction. It cannot endure.

Generalizing further, we find that throughout the whole field of machine bearings pressure is a coefficient, so to speak, of endurance and good performance. Exceptions may be pointed out, in the case of slow movement, but the rule holds good and has full recognition in the modern method of increasing the surfaces of bearings, which is the same, in effect, as reducing the unit of pressure.

Reverting again to the example named, suppose that the 50 horse-power is to be transmitted to a shaft revolving at a rate of 200 revolutions per minute, and the friction clutch is to be substituted by a band. This latter would, for example, be 10 inches wide, on a pulley 36 inches diameter, and the frictional-contact surface be not less than 500 inches of area, moving about 1,900 feet per minute. In the case of the friction clutch, the area of frictional contact would be, perhaps, an eighth as much and the velocity half as much; so the comparison of contact would be as 16 to 1, and the pressure to produce a given tractile effort would be in the same proportion. If the pressure on the band was 2 pounds per inch, that on the clutch would be 32 pounds per inch.

These quantities are roughly assumed; but, as a matter of fact, will, I think, come within the field of common practice. One of the conditions is destructive, the other is enduring; but this is not all.

Suppose the two means, a band and a clutch, are to perform the same work and to be frequently stopped and started, the band to be shifted to a loose pulley for this purpose. Here will arise a further distinction—one of importance—that has to do with both performance and endurance; that is the time or rate of engagement, or, in other terms, the control of pressure. In the case of the band, it must be shifted by degrees and by deflection edgewise to wind spirally upon the pulley to be driven; the increment of area and consequent slipping, which is an essential feature, has to be cumulative and gradual, avoiding overstrain and pressure. It is true a clutch can be engaged in

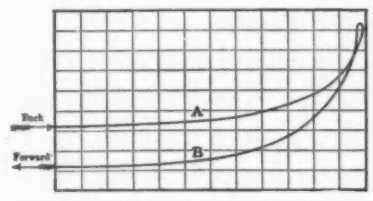


Fig. 1.—Suggestive Diagram of Momentum of a Reciprocating Table and Force of a Controlling Friction Clutch.

the same manner; but it need not be—is not in any but exceptional cases.

OTHER DIFFICULTIES TO BE OVERCOME.

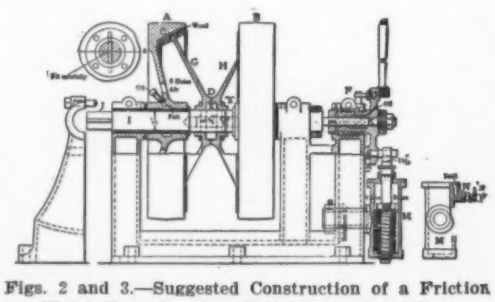
In the two features pointed out, we can see the causes that have earned friction clutches their bad reputation. There are other impediments, such as centrifugal force, frequent and unequal adjustment, with more that could be named; but the intensity of pressure and its irregular application account for a want of endurance, the chief fault of friction clutches.

This compendious "screed" is merely suggestive. A complete analysis that embraced all the elements that enter into friction clutches would call for graphic illustration and consume more space than is at present at my disposal; but the "game is worth the candle," if it will contribute to a new and improved form of these implements, so widely demanded in modern constructive arts.

POSITION OF FRICTION SURFACES.

In the preceding paragraphs the premises assumed related to two features—an admissible unit of pressure and the limit and time or rate of applying this pressure—but there are other conditions of operating to be considered, before preceeding to constructive design.

One of these is the position of the friction surfaces.



Figs. 2 and 3.—Suggested Construction of a Friction Clutch Engaging in a Predetermined and Controlled Interval of Time.

These, in practice, can vary from radial or normal to the shaft to parallel therewith and do so vary in practice. In the case of radial faces, the pressure to engage a clutch must equal that on the frictional faces and this introduces what are commonly perishable devices; besides, the wear at any point of the faces is as the speed at that point and is unequal, tending to a curve of "equal tangents," as it is called.

Such clutches are employed only for light purposes, because of the reactive strain on setting gearing, so that some angle is chosen, not only to reduce reactive strain, but to secure concentric wear and more uniformity of surface speed.

In clutches with their frictional surfaces parallel to a shaft and excluding embracing straps or brakes, the usual construction is an expanding interior member with great pressure and "toggle abutment" against the center or nave, also, sometimes, by coiling springs and in other ways, but always with interior pressure and commonly metallic-friction faces.

These features may not, at first, seem directly relevant to the present subject, but are so, nevertheless, if we are to reach a logical conclusion, and circumstances point to frictional faces oblique to the axis of revolution and of such inclination as will permit instant and automatic release, preserve concentricity and at the same time increase the unit of pressure by the wedging action. Such an angle for these faces should be 20 to 30 degrees from the axis.

SETTING OR ENGAGING MECHANISM.

The next feature to be noticed is what we may call setting or engaging mechanism. This must in all cases overcome a considerable resistance and in most cases sustain resistance through collars or what may be called running joints or bearings, that are apt to lack endurance and involve a considerable mechanism.

Taking into account the many and varied devices employed in setting, we find that velocity and consequent wear is generally their fault and while the strains or pressure cannot be avoided, we can reduce velocity by connecting through the axes of the shafts on which the clutches are mounted.

This latter seems to be the best manner of operating friction clutches, proved by its use in marine and other winches, also in winding and hoisting machinery. Reasoning inferentially, there can be no doubt of the advantages possessed by this method of operating through the axes of clutches. The details are reduced, the "pull" can be compensated and the velocity slow enough to maintain collars on the setting rods.

These remarks apply to any case where the ends of shafts are available, which, by proper design, can be almost anywhere. The subject is much wider in importance than would be imagined. It brings to mind an incident of twenty or more years ago, when a shrewd lathe man was observed stuffing his cap with waste and in reply to a question about headache, said: "No, it is those infernal friction clutches on the countershaft. A piece comes down here, every little while, usually on the top of my head."

In all these contrivances for setting clutches, such as cones, wedges, toggles, *et al.*, there are always pieces to "come down," come out or come loose, and practice, especially in hoisting and lowering gearing, tends to the center rod and a through cotter connecting to the movable-clutch member.

Previous to any remarks here upon constructive features, it is thought best to go over all the general premises and operating conditions. This is not an easy way for either the reader or for me, but it is the best way to get at the subject understandingly.

THE ENGAGING OF CLUTCHES.

The next element or feature to be considered is the setting or engagement of friction clutches—the most interesting part of the problem and from which may come copious suggestion for construction.

In most cases, the work of the clutches, or the resistance it may be called, is regular or at least uniform

* American Machinist.

and determinable, quantities that can be computed and demonstrated with their limit and degree. Opposed to this is the tractile force of the clutch; but the adjectives above do not apply to this, or at least are not applied to the setting or engagement of the clutches. This in many cases is performed by hand and without any rule whatever or any care.

There are, however, such a wide range of uses and adaptations, that it will be necessary to assume a concrete example, such as the stopping and reversal of reciprocating machines—a metal-planing machine, for example, which at this time is the subject of extensive experiment among the makers of machine tools in this and other countries. It is in extended use and affects directly the cutting or effective time of working with such a machine. Obviously the manner of proceeding should be by constructing a diagram as in Fig. 1, representing the two opposing forces, *A* the line of momentum for the mass or table of the machine and its load, and *B* the line of resistance by a friction clutch to overcome the momentum, stop and reverse the motion. All the quantities seem computable in a particular case; but this is not necessary here, so the diagram is of use only to illustrate what is meant and omits lines for inertia and reversing frictional resistance of the ways and so on.

From the features already discussed, the reader will be in the way of plotting to some extent the line *B* after *A* is assumed and is on the road of a logical solution and key to a suitable construction.

The line *A*, as remarked, is a definite and computable one, from assumed or known quantities, and obviously the line *B* must be the opposite in degree or force, but must contain certain conditions or factors, as follows: (1) maximum resistance required; (2) a limitation of force to guard against overstrain and accident; (3) a cumulative rate of resistance, with increment as indicate[illegible]ves; (4) how much the line *B* can be mo[illegible]time without imparting shock or damage [illegible]g and parts.

The last-named factor is one of experiment and introduces another of a constructive nature, namely: adjustable means to change and regulate the resisting force in the line *B*. This has to be varied to suit different speeds, now commonly provided for in metal-planing machines, and requires setting by sound and sight, thus constituting a peculiar use, but an extensive one, that embraces all difficult conditions and is selected for this reason.

It so happens, however, that the functions all lie within fairly cheap and durable mechanism, as will now be shown by the drawing, Fig. 2.

A SUGGESTED CONSTRUCTION.

The diagram, Fig. 2, is prepared to show how the preceding feature may be carried into operative effect. It is not intended for more and admits of a wide range of constructive design. Following out these several features, there is, first: the area of contact at *C*; taking into account the space and speed of right and left belts on *A* and *B*, the arcs of contact are about equal and the tractile force of the clutch and belts is about the same, not taking into account the reduced contact of the bands by reason of centrifugal force.

The pulleys or flywheels *A* and *B* form one member of each clutch and with the inner members *G* and *H* have webs of angular section to increase stiffness, also to permit housing and protecting the parts. The parts *G* and *H* are practically but one, but are in two parts to house the cotter *E*, which slides on and drives the shaft *I*, which connects at *J* to the machine to be operated.

The clutch movement, which can be from ¼ inch to ½ inch, is by means of the central rod *K* moved by an oscillating screw-nut that has a motion each way by hand or tappets and is forced right or left by a strong spring and piston *M* that has a cumulative force each way, but regulation as to time and also as to range. The time factor is by means of a liquid in the cylinder *M* that must flow from the top to the bottom as the piston rises and as the clutches engage, the time being regulated by a screw valve *N* seen in Fig. 3. The liquid is free to flow upward by a free-ring valve in the piston, as seen. Thus is provided an adjustable controlling force that is purely automatic.

The range of this engaging motion or the extent of pressure that can be applied on the clutches is determined each way by stops at *F*, which can be set accordingly. Thus the time or rate of closing the clutches is fixed and must by either hand or power occupy a certain space of time, otherwise they are liable to be jammed into action and injured. The distinguishing feature is that the clutches engage in predetermined time and in this respect differ from all methods hitherto attempted, so far as I am aware.

The angle for the frictional face, disposition and kind of tractile material, method of framing and indeed all the parts are the subject of varied constructive design, so long as the principle or mode of operating is kept in view, remembering the subject is "friction clutches to operate reciprocating machines."

It is suggested that reversing friction clutches should, like machine chucks, become an organized manufacture. No one wants to make such a device for a special use when the adaptation would be complete and the cost be half as much by an organized manufacture.

In preparing the example shown, there was in mind belts five inches wide moving two to four thousand feet per minute, but in use the same machine could answer for two to ten horse-power, a circumstance that especially favors organized manufacture.

A NEW VALVE GEAR FOR GAS ENGINES.

A SIMPLE MECHANISM FREE FROM BACK-ACTION.

IMPROVEMENTS in valve gears for steam engines are made chiefly with a view to obtaining greater economy in steam consumption; improved steam-engine valve gears aim at reducing clearances and giving a quick cut-off.

The length to which inventors of valve gears will go, by way of adding complication, in order to achieve this result needs no comment.

That there are other worthy objects to be sought for, such as simplicity and fine governing, even in designing steam-engine valve gears, has sometimes been understood; and the most successful valve gears for steam engines are those in which a due regard has been given to these other things.

In a gas engine the consumption of gas is not affected

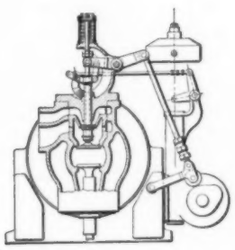


FIG. 1.

at all by fine clearances and quick cut-off, therefore improvements in gas-engine gears are not so much directed to obtaining greater economy in gas consumption as toward simplicity of fine governing.

With this object in view the "hit-and-miss" method is being abandoned in favor of some form of "variable-admission" gear, which admits a charge of greater or less value to the cylinder at every suction stroke.

This is effected either by a separate throttle-valve in the mixture passage, or the gas passage, or in both; or by automatically varying the opening of the gas, or inlet, or both valves.

Apart from employing a throttle-valve there are in use two common forms of "variable-admission" gear—one operating on the main inlet, or mixture valve, and the other operating on the gas valve.

Up to the present the former type has been considered the simpler, the latter system being supposed to involve the adoption of two separate valve-boxes and tackle.

Notwithstanding this, several makers of large gas engines, viz., the Nurnburg Co., Ehrhardt & Sehmer, the Cockerill Co.—to mention some—build their engines on these lines, putting up with the added complication involved rather than adopt a less correct system.

In addition to this system giving a constant high compression, thereby insuring more perfect combustion, it should be remembered that gears operating on the gas valve have only to open it against its comparatively light spring, thus causing a light back-action on the governor; whereas gears operating on the main inlet, or mixture valve, have to open this valve against the necessarily heavy spring which keeps it closed, thus causing a heavy back-action on the governor.

The disturbing action on the governor of any positive action valve gear, we take it, is a fixed proportion of the resistance of the spring against which the gear operates to open the valve.

Therefore, if fine governing is required, a gear operating on the gas valve is much to be preferred.

If a trip gear is used there is, of course, no disturbing action on the governor, due to the opening of the valve; but when the gas, or mixture valve is operated by a trip gear it is liable to rebound and cause clatter.

Another advantage of this system of varying the quality and not the quantity of mixture drawn into the cylinder is a quieter and smoother running engine, due to the engine always taking in a cylinder full of mixture for compression and having no tendency to suck open the exhaust and inlet valves, which can therefore be less heavily loaded, with consequent less wear of cams, etc.

Messrs. Crossley have adopted a simple form of gear operating on the gas valve, which does not involve a separate tackle to open the gas valve. It is arranged co-axially with the main valve and operated pneumatically.

The valve-operating mechanism about to be described is similar to Messrs. Crossley's, but the gas valve is operated mechanically.

The main feature of the new gear is that the gas valve, carried on the stem of the main inlet-valve, is operated from the same cam and rod, but in such a manner that, while the main valve always opens to the same extent, the gas valve opens to a varying extent determined by the governor.

The gas valve is arranged to close with the inlet valve, so that, however small the quantity of gas admitted, the mixture is always richest at the firing end of the cylinder; and, in order to keep the constant volume of mixture sufficiently rich, to insure combustion when running on very light loads, a ring on the bottom part of the gas valve partly throttles the air inlet.

Referring to the illustration (Fig. 2) the main inlet valve, *A*, is opened in the usual way by the lever, *B*, actuated by cam and rod from the half-speed shaft.

The gas valve, *C*, is opened, more or less, by the levers, *DD*, which pass, one on either side of, and connect with a swiveling crosshead, *E*, attached to the gas valve stem.

These levers have their fulcrum at *F*, on arms *GG*, which are capable of being moved by the governor.

The levers at the other end are connected by a link, *H*, to the main inlet valve lever, as shown. The spindle, *J*, to which the arms, *GG*, are keyed, is connected to the governor by a lever and rod.

When the governor is in its top position, the arms are in the position shown, with the fulcrum at *F*, and

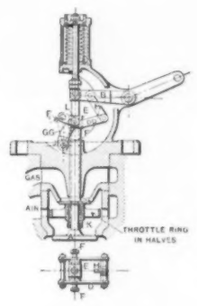


FIG. 2.

the opening of the gas valve is *nil*, there being no leverage.

When the governor is in its bottom position, the fulcrum of the levers is at F_1, and the gas valve has its maximum opening, due to the leverage thus obtained.

The levers *DD* are made of such shape that, whatever the position of the governor, the gas valve is always closed when the inlet valve is closed. Also a small clearance at *L*, between the levers and the swiveling crosshead, allows the light spring at *K*, between the gas valve and main inlet valve, to insure that the gas valve shall properly seat itself when closed.

The resistance of this spring is the only resistance, apart from friction, against which the gear operates to open the gas valve, and it will be noticed that, when the gear is in its worst position, viz., as shown in the illustration, the pressure on this spring is relieved, due to the opening of the main inlet valve.

Fig. 1 shows the gear in connection with Hall's patent frictionless governor, a description of which appeared in a recent issue. The gear is the invention of, and has been patented by Mr. H. R. Hall.—Page's Weekly.

A REMARKABLE AUTOMOBILE CHART.

A MECHANICAL SIGN POST.

AUTOMOBILE tourists—and that term includes about everyone who owns a motor car—will be greatly interested in a new invention of Joseph W. Jones, which is a mechanical sign post.

Briefly, the invention is a revolving card whose rim is divided into 100 miles and tenths of a mile 176 yards to a division). On the other frame is a hand or pointer. The map is set by a screw, when starting, to the place on the map where the trip begins. As the automobile moves the map revolves slowly under the pointer. At the end of 100 miles a new map is put on which shows the continuation.

A long flexible driving shaft connects the map with the front of the wheel. By perfectly adjusted gearing, the speed of the road turns the 100-mile disc slowly under the pointer. The chart and geared mechanism are protected by a case. The flexible driving shaft makes it possible to pass the map for reference to passengers in the front seat or rear seats. The map is carried in a leather attached to the brass rail and is supported by a frame so that it can be easily read from the tonneau. By means of the flexible shaft, the map may be either hung from the robe rail, on the dashboard, or carried in the lap as preferred. As the wheels of the car revolve the map in the case turns a proportionate distance, and it is always possible to tell where you are. It is, of course, necessary to follow the route prescribed on the route card, but in case, for any reason, the driver makes a detour or takes a wrong road, it can be reset in a moment's time.

CHART AS USED IN THE TONNEAU.

Route cards covering all sections of the country are to be furnished with the device.

WIRELESS TELEGRAPHY NOT AFFECTED BY MAGNETIC STORMS.

ON September 25th, 1909, the solar activity, which had already manifested itself by sunspots and otherwise, produced on the earth an aurora borealis and a violent magnetic storm, which caused the declination needles of the magnetic observatories at Kew, Paris, and elsewhere to oscillate 1½ degrees on each side of the normal position. This magnetic storm, like its predecessors, seriously interfered with the operation of those overland and submarine telegraph lines which use a single conductor and complete the circuit through the earth. It is well known that the interruption of the service, in such cases, is due to irregular earth currents which are superimposed upon the telegraphic current and made the signals unintelligible. These earth currents, which are observed in wires, the ends of which are connected to earth at points distant from each other, show that the earth, at such times, is comparable to a sphere of moderate conductivity, charged to a potential which varies from point to point. The theory of these electric charges is still imperfect.

On September 25th last the telegraph service was interrupted, not only in Europe, but also in North and South America, and in India, where telegraphic communication between Bombay, Calcutta, and Madras was suspended for six hours. All of the submarine cables were also affected. Little disturbance was experienced, however, in lines running north and south. The same peculiarity had been observed in several previous magnetic storms.

During the whole magnetic storm, even when it was most violent, the wireless telegraph systems remained perfectly free from disturbance. In the London Electrician, Dr. Eccles states that he operated a wireless station in Sussex for ninety minutes during the magnetic storm and not only received messages as clearly as usual, but did not detect any abnormal frequency or intensity in the electric waves of unknown origin which are commonly observed.

A. Boutquin, in a recent issue of Ciel et Terre, lays stress upon the immunity from terrestrial magnetic disturbances which is fortunately possessed by wireless telegraphy, and which he was the first to point out in connection with the still more violent magnetic storm of October 31st, 1903. He adds that this fact should be taken into account in seeking the origin of these magnetic disturbances.

These facts agree very well with the hypothesis that the magnetic perturbation is due to the influx of electrified particles, or ions, which are expelled from the sun and move toward the earth with a comparatively small velocity, while if the electric influence were propagated from the sun to the earth with the velocity of light or electromagnetic waves (186,000 miles per second) it would be difficult to understand why it does not, like electromagnetic waves of terrestrial origin, affect the apparatus of wireless telegraphy.

RADIO-ACTIVITY OF ORDINARY MATTER.

THE experiments of Campbell, who adopted a method of measurement more sensitive than that employed by Madame Curie, indicated the probable existence of radio-active properties in potassium and lead. Elster and Geitel have proved, however, that the radio-activity of lead is due to the presence of an impurity, which is identical with radium F.

Levin and Ruer, who had also studied the radio-activity of potassium, have recently extended their researches to most of the chemical elements. They employed, as detectors of radio-activity, photographic plates wrapped in black paper, on which were laid plates of brass 1/25 inch thick and 1½ inches square. An opening about ½ inch square, in the center of each brass plate, was covered with a piece of silk paper, on which the substance to be tested was placed. The exposure continued about six months, during which interval each plate, with its accessories, was inclosed in the cardboard box in which it was originally packed, and kept in a dark room.

In these conditions of total exclusion of light it was impossible to detect any difference in the slight darkening of the film beneath and outside of the brass plate. This amount of discoloration was taken as a zero point in estimating the effects produced by the substances under examination. A particular advantage of this method is the accumulation of the effect, which makes it possible to use very small quantities of the various substances. The method is sufficiently sensitive to detect a radio-activity one million times smaller than that of the α rays of radium.

In the first series in the periodic table of the elements, all salts of potassium and rubidium which were tested affected the photographic plates, while no perceptible effect was produced by lithium, sodium, copper, silver or gold, the salts of any of these metals or of ammonium, or the nitrate of caesium.

In the second series, beryllium produced a very slight and doubtful effect, while the salts of magnesium, calcium, strontium, barium, zinc, cadmium, and mercury proved inactive.

In the third series the compounds of lanthanum were found to yield a very short-lived radio-active emanation, the suspected identity of which with thorium emanation could not be rigorously proved. The other elements of this series, boron, aluminium, yttrium, indium, and thallium, produced no effect on the photographic plates.

In the fourth series four specimens of cerium compounds of diverse origin exhibited radio-active powers ranging from 1/10 to 100 times the radio-activity of potassium, but as the most active specimens were found to contain thorium emanation, there is no evidence in favor of the radio-activity of pure cerium. Experiments with specimens of lead, of which some were one hundred years old and others were taken from a Pompeian aqueduct, revealed not a trace of radio-activity, and thus confirmed the conclusions of Elster and Geitel. The other elements of this series that were tested, including carbon, in the forms of charcoal and graphite, silicon, titanium, zirconium, tin and germanium, likewise failed to affect the photographic plates in the slightest degree.

In the fifth series the only substances which unquestionably blackened the plates were salts of antimony and, even in this case, the effect may have been caused by potassium salts, present as an impurity. The compounds of niobium, tantalum, and the metals of the rare earths gave uncertain results, and phosphorus, vanadium, arsenic and bismuth produced no effect whatever.

In the sixth series sulphur, selenium, and tellurium, in the free state, and the salts of chromium, molybdenum and tungsten proved inactive.

In the seventh series neither the halogens, in combination with sodium, nor the salts of manganese, exhibited the slightest radio-activity.

In the eighth series iron, nickel, cobalt and the metals of the platinum group proved equally inactive. The effect produced by osmium and ruthenium, in the form of powder, appears to be due to chemical action.

A few years ago the German engineer, Otto Schlick, devised a plan for preventing the rolling of ships by placing in the hold a heavy flywheel and causing it to rotate very rapidly about a vertical axis. Schlick's gyrostat was applied, experimentally, to a German torpedo-boat, with which very encouraging results were obtained, and it has since been employed successfully in a number of other vessels. Nevertheless, the invention is not yet so perfect, or so well understood that favorable results can be predicted of its application to every new vessel. The owners of a Scotch yacht of 241 tons, on which a gyrostat was installed last year, are about to transfer the instrument to a new yacht of 180 tons, because of its unsatisfactory performance on the larger vessel. In comparatively smooth water, the apparatus worked well on the large yacht, and greatly diminished the rolling, but when the force of the waves exceeded a certain limit the speed and, consequently, the stabilizing action of the gyrostat were diminished by its very reaction to the rolling motion. Hence it appears necessary for the gyrostat to be driven by a motor of power adequate for the maximum work required of it. Another requisite is a practical system of regulating the power, instantaneously, in accordance with the continually varying force of the waves.

CHART ACTUATED BY A FLEXIBLE SHAFT AS SHOWN.

From some experiments conducted by Prof. Turner at the University of Birmingham, some new observations have come to light pertaining to the subject of transparency in metals. The only metal hitherto associated with transparency has been gold; but from the investigations of Prof. Turner it has been discovered that silver and copper also possess this quality when subjected to the proper treatment. While the observations are of no known practical utility they have attracted attention in scientific and artistic circles, as the color effects transmitted by the metals under such conditions are said to be of striking interest.

THE GERMAN "DREADNOUGHTS."

WHAT IS THE "NASSAU" TYPE?

AN extraordinary diversity of opinion appears to obtain as to the merits of the German dreadnoughts compared with corresponding vessels of the British navy. In Germany there are two distinct classes of opinion. One school holds that the "Nassau" represents the last word in everything. They point out that she brings as many big guns to bear as the "Dreadnought" in any position, and that she has in addition a 6-inch battery that is lacking in the British vessel, while her lesser speed is explained away by the argument that speed is for cruisers, not for battleships. Thus one view of the picture. Quite another aspect is given to it by retired German naval officers, who complain somewhat bitterly that the mountains have been in labor and produced a mouse. These officers argue that the vessels of the "Nassau" class are simply adaptations of the British Lord Nelson, and that they in no way justify the theatrical secrecy in which their construction was shrouded. They point out that the disposition of the artillery is such that there are always four big guns unavailable; and they ask, somewhat pertinently, wherein lies the triumph of carrying two more big guns than the "Dreadnought," and yet in not having a single extra gun to use. They admit circumstances in which the 6-inch batteries of the "Nassau" would be of considerable advantage, but against this contend that British dreadnoughts, having the speed gage, would be more or less in a position to choose the range, and would obviously maintain a distance at which the 6-inch gun was relatively useless. In fine, supreme disappointment would seem to be the dominant note with these gentlemen.

Between these two conflicting opinions the truth is probably to be found. When all is said and done, it cannot be claimed for the "Nassaus" that they represent any novelty. They are simply perfectly commonplace developments of the "Deutchland" class, with big guns substituted for the 6-inch upper deck guns of those ships. Of novelty, such as is embodied in the "Dreadnought" design, there is nothing whatever, and it is further rumored, on fairly good authority, that they draw at least 3 feet more than they were designed to draw. This may be put down as a case against them. Of our own dreadnoughts it may, on the other hand, be said that they were produced on the assumption that the importance of the 6-inch gun was an exploded idea, and that the naval battle of the future would be entirely decided by the big gun. The more cautious Germans have accepted the big gun, but retained the 6-inch also, so as to be on the safe side. The value of the 6-inch for battle purposes is one of those problems that only the next naval war can decide. But its utility as an anti-torpedo armament can hardly be exaggerated. That we have somewhat tardily realized this is perfectly clear from the fact that the 12-pounders of the "Dreadnought" gave place to 4-inch guns in later models, and in the "Neptune" to 4.7-inch guns. It is probable that upon these secondary guns the issue of a fight would be ultimately decided. The big guns in either design are so nearly equal that any battle result must depend upon gunnery pure and simple. The issue is therefore left to the secondary armament and its, at present, unknown value. It is, however, difficult for any unbiased critic to arrive at any conclusion other than that the German policy of "going slow" and retaining the 6-inch gun is the safer; even though that retention entails corresponding disadvantages, such as unduly increased draft and the overloading of a ship with more guns than she can reasonably be expected to carry upon her displacements. Our dreadnoughts represent a bold plunge into the unknown, likely either to be quite right or altogether wrong; whereas German design has proceeded on the principle of striking a mean, so as not to be altogether wrong, whatever results the naval warfare of the future may produce.

This peculiar conservatism is characteristic of Germany, which has never believed in giving hostages to fortune. It is an old proverb that "nothing can be won without taking risks." In our dreadnoughts we have taken these risks with an almost abnormal candor. It rests with the future to show whether we were justified or not. Incidentally, it should be remarked that up to the very last moment a very strong body of opinion in German official circles was in favor of a uniform secondary armament of 4-inch guns, instead of the mixed 6-inch and 3.4-inch armament that has been provided. Even, therefore, across the North Sea, absolutely definite opinions by no means prevail. But we feel that it is well that the public should realize that in our naval policy we have taken far bigger steps than other nations have been inclined to take, and that these facts cannot but add to the general sense of unrest that obtains. British naval construction to-day is, by the force of circumstances, of the nature of a vast experiment. We do not pretend to say whether that experiment is right or wrong. That the future may, unhappily, have to decide.—The Engineer.

THE PRESENT STATE OF THE PHYSICAL CHEMISTRY OF COLLOIDS.

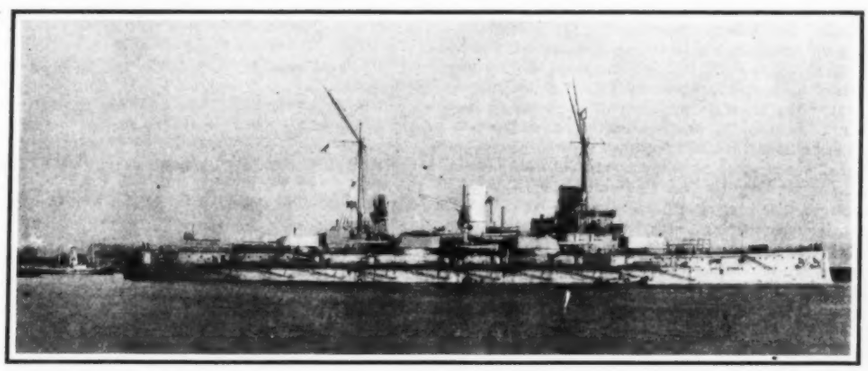
By A. LOTTERMOSER.*

THE laws which govern the behavior of matter in the gaseous state are peculiarly simple and universal. They may be briefly summarized as follows: 1. For a given mass of gas the product of volume into pressure is constant for a given temperature (Boyle's law).

2. With varying temperature this product is simply proportional to the absolute temperature (whose zero lies at —273 deg. C.). This is usually known as Charles' law or Gay Lussac's law.

3. When several substances in the gaseous state react with one another chemically, the *volumes* of the several substances taking part in the reaction are in simple numerical proportions. The discovery of this law also is due to Gay Lussac.

4. Lastly, the third of these laws, taken in conjunction with Dalton's law of constant proportions (according to which the masses which combine chemically are in simple numerical ratio), led Arogadro to enunciate the fundamental hypothesis which goes by his name, and which states that equal volumes of all gases (under similar conditions of temperature and pressure) contain the same number of molecules.



THE GERMAN DREADNOUGHT "NASSAU."

Mainly through the work of Pfeffer and Van't Hoff on osmotic pressure, it is well known that precisely similar laws hold for dilute solutions.

All these facts are harmoniously represented by a mechanical model, as it were, on the assumption that a gas consists of individual molecules flitting to and fro irregularly in the containing vessel, the pressure upon the walls of which is thus produced by the impacts of innumerable molecules. A very similar state of affairs appears to exist in a solution, although in this case the molecules are packed much closer to one another, and their path is accordingly changed in character.

Until a comparatively short time ago this explanation, though substantiated by a bulk of evidence, was still in a large measure hypothetical. But recent investigations of colloidal solutions have gone very far to establish the "kinetic" theory of matter, as it is called, upon a basis of almost direct evidence. For it has been found that the properties of colloidal solutions grade imperceptibly into those of the ordinary or true solution. In the latter, it seems, we have individual molecules of the dissolved substance distributed through the solvent. A colloidal solution contains, similarly dispersed through it, agglomerations varying in size from the ultramicroscopic to the microscopic. And the point of interest is that the microscopic particles actually exhibit plainly to the view the movement which according to the kinetic theory is characteristic of the ultimate particles of matter, the molecules. And more than that, this motion corresponds quantitatively (but for a constant factor) to that which calculation requires.

Colloidal solutions display a number of remarkable properties, some of which remain as yet unexplained. One phenomenon which had been early observed is that the dissolved or suspended material, the hydrosol, as it is called, tends to travel (migrate) through the solution if a difference of electric potential is established therein. The direction of the migration, relative to the potential gradient, depends on the particular hydrosol selected. The particles of the hydrosol therefore carry electric charges, and as a matter of fact these charges are essential to the stability of the solution: the introduction of electrolyte ions carrying an opposite charge may cause precipitation of the colloid. The question arises, what is the origin of the charge upon the particles of colloid? The answer seems to be furnished by the phenomenon of "adsorption." It is well known that every solid "adsorbs" liquids and gases in proportion to the extent of its exposed surface. Very small particles will be particularly prone to this effect, since the ratio of surface to volume increases as the dimensions decrease. But the amount of any substance thus adsorbed depends also on the nature of the substance. A colloid dispersed through the solution of an electrolyte will therefore in general adsorb unequal proportions of positive and negative ions, and will thus become invested with an electric charge. By the addition to the solution of those ions of which there is a deficiency upon the colloid particles, the equilibrium can be so shifted as to just neutralize the charge upon those particles. The colloid is then precipitated. There is, however, a class of colloidal solutions which cannot be thus precipitated. They have been termed by Wo. Ostwald "emulsion colloids." It is probable that these form a kind of cellular network through the liquid, and are thus distinguished from the other class, the "suspension colloids," in which the individual particles are probably separate from one another. The emulsion colloids are not only themselves resistant against the influence of electrolytes, but are able, when present together with suspension colloids, to protect these in a measure from the precipitating action of the ions of an electrolyte.

The question naturally arises, how two hydrosols carrying opposite charges will influence one another. Experiment shows that mutual precipitation may occur, but only when the two colloids are present in a perfectly definite proportion. And the more pronounced the colloidal character of the two substances, the narrower are the limits within which the proportions must lie in order that precipitation may occur.

The precipitation of a hydrosol by an electrolyte is often bound to certain specific conditions. Thus if 48 c. c. of a twentieth-normal solution of potassium iodide is added drop by drop to 50 c.c. of a twentieth-normal silver nitrate solution, a positively charged colloidal silver iodide solution is obtained. The quantities are such that there is an excess of 2 c. c. of twentieth-normal silver nitrate solution. This holds up the hydrosol and imparts a positive charge to it. If to this colloidal solution we add, say, one-half on a c. c. of twentieth-normal potassium iodide solution, no precipitation occurs, as there is still an excess of Ag ions, which hold up the hydrosol. But if exactly 2 c. c. of such a solution is added, precipitation results. This effect is independent of the particular concentrations used, and depends only on the actual quantities. If, however, the limiting ratio is rapidly and considerably overstepped, by adding three or four c. c. or indeed any large quantity of the twentieth-normal potassium iodide solution, then again no precipitation occurs. At the same time the charge of the hydrosol changes from positive to negative. This effect, however, does not depend on the concentration of the solutions used. If the potassium iodide solution exceeds a certain strength, this overstepping becomes impossi-

* Adapted from Zeitschrift für angew. Chemie, 1909, p. 1417.

ble, and precipitation occurs as soon as the equivalent proportions are approached within a certain close limit.

Water is not the only substance that can serve as solvent for colloidal solutions. Similar results have been obtained with ether. Indications, however, are that absolutely pure ether would be incapable of functioning in this way. The explanation of this is no doubt to be found in the fact that pure ether is almost absolutely unionized. The presence of impurities, such as traces of alcohol, water, etc., furnishes the ions which, as outlined above, are necessary for the formation of a hydrosol.

We have noted that electrolytes can cause the precipitation of a hydrosol, by supplying the requisite ions to neutralize the charge upon the colloid particles. The question may be asked, whether in the absence of electrolytes a colloidal solution is stable for an indefinite period time. The answer is negative. As a matter of fact the larger particles slowly grow in size at the expense of the smaller, and finally attain such magnitude that they settle out by gravity. This separation may be greatly accelerated by applying centrifugal action instead of relying upon gravity.

Here again it is interesting to note how gradual is the transition from colloidal to true solutions: Gravity is insufficient to cause any appreciable stratification in a true solution. But according to the experiments of de Bryun this effect can be secured by centrifugal action.

It has been customary to suppose that the particles of the colloid in a hydrosol are amorphous. Latterly there has been a tendency to veer around to the opposite view. Zsigmondy has shown that the formation of the hydrosol can be initiated by the introduction into a suitable solution of a small quantity of the ready formed hydrosol. This action is strongly suggestive of the "catalytic" effect of crystals upon supersaturated solution, and the inference seems rather obvious that the particles of hydrosol are crystalline.

Only a few of the more striking facts known to-day about colloidal solutions have been here presented. This comparatively new branch of physical chemistry has of late years grown with the force of an avalanche, and there can hardly be any doubt that it is destined in the near future to bring further disclosures of the greatest theoretical and practical importance in chemistry and the allied arts and sciences.

STAMMERING.*

WITH SOME SUGGESTIONS AS TO MODERN METHODS.

BY G. HUDSON-MAKUEN, M. D.

IT has been estimated that there are upwards of three hundred thousand stammerers in the United States alone. It is quite probable that about one-fourth of the entire number would overcome their defect of their own accord, or at least with the little help that always comes from interested friends, but the remaining three-fourths present a very different problem, is that they must expend a great deal of time and energy upon the work of recovery, and secure in addition the assistance of those having acquired a good working knowledge of the anatomy, physiology, psychology, and pathology of the organs employed in the production of speech.

Stammerers are not alike, except in a few characteristics, and they require, therefore, a certain amount of individual treatment. Our experience with the one-fourth of the entire number forms no criterion as to a basis for the general treatment of stammering, but nevertheless, because of the great ease with which these exceptional few are managed, inexperienced observers have reached false conclusions and formulated so-called "methods" of treatment which are misleading, fallacious, and even absurd.

For instance, a stammerer is told to nod his head whenever he speaks, and because this procedure happens in his particular case to divert his attention sufficiently long to enable him to speak freely for a time, he thinks he has made a discovery and he immediately evolves a theory and establishes an institute with a secret "method" which consists solely in nodding the head in unison with the natural rhythm of speech.

Another advises beating time with the forefinger and thumb, or with the hand and arm or with the foot, during the process of speaking, and each one of these schemes has been dignified as a "method" which has been dispensed for a consideration, and under bonds of secrecy. Experiences similar to this have generally been the starting point of the numerous "methods" which have been promulgated from time to time, and which have resulted only in confusion to the many really severe stammerers who have been seeking relief.

There is even now a separate and distinct method which characterizes nearly every school and teacher engaged in this work, and these methods in many instances amount to little more than tricks, to beguile the stammerer into freedom of speech, while his mind is preoccupied with something else.

It is well known, of course, that many people stammer under certain conditions largely because they think they will. All their past experiences with speech have combined to confirm them in the thought, and it soon becomes a sort of "fixed idea." It is nothing for which the stammerer should be censured, because it is a perfectly natural consequence, and the idea or notion that he will stammer under certain conditions will remain fixed until it has been supplanted by absolute confidence in his ability to speak freely under all conditions.

That this confidence can be acquired in nearly all cases is my firm belief, but to be absolute the confidence must carry with it the ability. It is not enough for the patient to think that he can do it or even to know that he can do it, but he must know that he knows he can do it. A stammerer is never thoroughly and permanently cured who has not so mastered the physiology and psychology of speech that should it ever become necessary he can recure himself. He must, of course, take heed lest he fall, but should he fall he must be able to pick himself up again.

In reviewing briefly the history of the treatment of stammering, we find that such men as Galen, Celsus, Klencke, Dieffenbach, Detmold, Wolf, and others, supposing that the difficulty existed entirely in the tongue, directed their attention chiefly to this organ, and we have records of mechanical contrivances for holding the tongue in certain positions, and such surgical operations as divisions of the hypoglossal nerve, the lingual frenum and the various extrinsic and intrinsic muscles of the tongue. Dieffenbach went so far as to remove wedge-shaped sections of the tongue, Galen cauterized it, Detmold passed needles through it, Kustner applied embrocations, cauteries, and blisters, and Yearsley and Braid excised the tonsils and uvula. Others suggested holding cork between the teeth, pressing the thumb on the chin, lifting the tongue to the palate, beating time, as I have said, with the head, the thumb and forefinger, the arm and the foot, and numerous other such schemes. The story of Demosthenes, struggling to speak with pebbles in his mouth, is well known, but the probabilities are that the pebbles might better have been left upon the seashore, and that Demosthenes became a great orator not because of the pebbles, but in spite of them.

I do not wish to be understood as characterizing all these practices for the cure of stammering as being fallacious, for many of them may have some value in connection with a well-ordered and scientific treatment. To suppose, however, that the tongue is chiefly at fault and to direct our treatment toward this organ, whether the treatment consists in the application of mechanical contrivances, the knife or what not, is manifestly absurd and should not be thought of for an instant. The trouble is not so much in the tongue, nor in the lips, nor in the palate, nor in the pharynx, as it is in something back of them all. It is not so much in the peripheral as it is in the central mechanisms of speech. And thus it happens curiously enough that there is a grain of truth even in the theory and practice of surgery for the cure of stammering, and it is found in the psychic impression of the operation.

I, myself, often think it fortunate on this account when there are tonsils and an adenoid to be removed, a septal deflection to be corrected, or an elongated uvula to be snipped; but these are operations, of course, which always tend toward the betterment of speech whether or not it is of the stammering sort, and they are operations, too, which are frequently indicated in these cases. I have been especially impressed with the large number of stammerers having intranasal pressure due to septal deflections and spurs.

History records also various educative methods for the treatment of stammering, many of which are theoretically and practically sound. Making use of opposing movements in respiration and vocalization, regulating tongue and lip action, exercising patients on difficult words, making use of rhythmic exercises, and whispering exercises are among the most important, but no one of these methods nor all of them combined can be regarded as a complete system for the cure of this affection.

The scientific treatment of stammering must have in view the actual substitution of normal speech for abnormal speech, and its aim primarily, therefore, should be not the cure of the stammering, but the development of correct speech. The cure of stammering should be regarded as of secondary consideration, although of course it follows as a natural consequence. The stammerer's speech is faulty in every particular. His central as well as his peripheral mechanisms are out of gear and his mental attitude toward speech is wholly wrong. The instrument is out of tune, and the player is unskilled in its use. He cannot retune his instrument, and if he could he would be unable to play upon it. The affection, therefore, is a complicated one, involving not only all the various mechanisms of speech, but also some of the higher intellectual and emotional centers of the brain. Indeed it involves the whole being, and its scientific treatment, therefore, must have for its purpose a thorough re-education of the individual; it must supplant his stammering speech with normal speech; it must make it easier for him to speak freely than to speak hesitatingly; it not only must correct the stammering habit, but it must remove the fear of stammering, upon which much of the trouble depends.

If we correct the habit, without, at the same time, restoring the patient's confidence in himself and in his ability to speak freely, the cure will be only temporary, and if we develop confidence in the patient, by the use of the so-called suggestive method, whether it be given in the hypnotic or waking state, without, at the same time, correcting the physical habits, as is frequently done, the results are only temporary and of course unsatisfactory.

It is not unusual to hear of stammering being cured in a few treatments or in a few weeks, but it is quite unusual to hear of such rapid cures being permanent. It is possible in nearly every case, by a short-cut suggestive method, to appear to cure stammering, and hence it is that the commercially inclined "stutter doctor" is able to guarantee a cure and even to promise to refund the money in case of failure. A written guarantee of this sort is nearly always given in these institutes, but no one has ever yet heard of the money being refunded, although it is a fact that only a few of the patients are actually and permanently cured. On the other hand, many of them are often made distinctly worse by their unfortunate experience.

The stammerer must be taught to speak in somewhat the same way as a person is taught to play upon the violin or the piano. The stammerer's instrument, of course, must be put in good condition by the removal of all obstructions to good speech, and then, as in the case of the would-be violinist or pianist, he must be taught to play upon this instrument. The exercises, which are purely educational and physiological, must continue for a sufficient length of time to enable the patient to form entirely new habits of speech, and they must, of course, be adapted to the special requirements of each individual case.

Stammering in the majority of instances, therefore, cannot be cured in a few weeks. On the contrary it often requires several months or even years to bring about the desired results. The man who guarantees to cure stammering in six weeks, or indeed who guarantees to cure it at all, is either ignorant of the true nature of the affection or possessed of some ulterior motive, and is therefore not to be trusted.

* Read in the Section on Eye, Ear, Nose and Throat Diseases, Medical Society of the State of Pennsylvania, Pennsylvania Session.

About a year ago considerable prominence was given to the approaching scarcity of commercial timber. Recent official estimates show that consumers have no reason to abate their efforts for the conservation of forest resources throughout the world. These indicate that in the United States the annual forest growth is less than one-third of the consumption. In New Haven County, for instance, it is stated that for the year 1907, the timber cut was 120,000 cords, while the annual growth on all types of forest land reached the total of only 70,000 cords. The net reduction of 50,000 cords a year means that supplies of merchantable timber in the country will be exhausted in roughly twenty years.

HEAT AND MUSICAL PITCH.

THE INFLUENCE OF TEMPERATURE ON INSTRUMENTS.

BY THO. FAISST

IN musical circles, and especially among orchestral players, it is regarded as an unquestionable fact that the pitch of an orchestra rises in the course of a performance, often to so great an extent that, toward the end of the concert or opera, the sopranos and tenors experience unusual difficulty in producing their highest notes. The rise in pitch is seldom perceived by the auditors, because the instruments are kept in tune with each other by frequent tuning, so that the pitch of the entire orchestra is raised uniformly and gradually, and it is impossible to compare the final pitch directly with the initial pitch. If such a comparison could be made, the change of pitch would be very noticeable. It is generally assumed that the gradual elevation of the temperature of the auditorium during the performance has something to do with this rise in pitch but diverse and frequently absurd views are held regarding the connection between the two phenomena. It is often asserted, for example, that the dimensions of the wind instruments are directly affected by the increase in temperature, but the exponents of this theory forget that the effect of heating would be an expansion of the instruments and that this would make the pitch lower, not higher.

The writer was once able to make a direct comparison between the initial and final pitches, during the production of a choral work in which the orchestra was supplemented by an organ. The pipes of an organ are divided into two principal classes, known as flute pipes and reed pipes. At the end of this performance the pitch of certain of the reed pipes was distinctly lower than that of the flute pipes. The organ had been tuned very accurately before the performance, when the air of the room was comparatively cool, and it was evident that this striking discordance was caused by the subsequent elevation of the temperature of the auditorium. These organ pipes (a trumpet register) appeared to be too low, because they were lower than the general pitch, but more careful examination proved that they had preserved the intial pitch, while the general pitch had risen.

The pitch of a reed pipe is determined mainly by the length, breadth, thickness, and elasticity of its reed, or tongue. It can easily be proved by calculation and experiment that a rise in temperature of 20 or 25 deg. F., such as would be likely to occur in such a case, could not affect the dimensions or the elasticity of the metal tongue sufficiently to produce the observed discordance, or even to cause a variation in pitch that the most sensitive ear could detect. Hence the reed pipes, though apparently flat, really preserved the initial pitch of the organ and orchestra.

The pitch of an open flute pipe, the sound of which is produced by the vibration of the column of air in the pipe, without the aid of a vibrating metal tongue, is equal, numerically, to the velocity of sound divided by twice the length of the pipe. Now the length of an organ pipe, like that of a metal tongue, may be regarded as invariable in practice, but the velocity of sound varies appreciably with the temperature. At the freezing point this velocity of sound in air is about 1,100 feet per second and it increases at the rate of about one foot per second for each degree F. of rise of temperature. This increase in the velocity of sound in air is due to the expansion and rarefaction of the air caused by heating it, for the velocity of sound in a gas is inversely proportional to the square root of the density of the gas. As oxygen, for example, is 16 times as heavy as hydrogen, the velocity of sound in hydrogen is four times its velocity in oxygen, and an organ pipe filled with hydrogen produces the double octave of the note which the same pipe emits when filled with oxygen. The density of air and, consequently, the velocity of sound and the pitch of an organ pipe, are affected by other conditions besides the temperature, but we cannot stop to consider these conditions in detail. The humidity of the air, for example, plays an important part.

Now it can be shown, by calculations based on the known laws of sound and gases, and also by experiment that even the slight diminution in the density of air which is produced by a rise of 20 deg. F. in temperature is sufficient to raise the pitch of a flute pipe of the organ by an amount that is readily detected by a musical ear. If the temperature of the air is 59 deg. F. at the beginning and 77 deg. F. at the end of a concert, as may very well happen, the velocity of sound in that air is about 1,120 feet per second at the opening and 1,140 feet per second at the close of the performance, and the pitch of the flute pipes rises in the same ratio of 1 to 1.02. If one musical note is produced by a certain number of vibrations per second and another note by twice that number of vibrations, the two notes are said to differ by an octave. That is, the musical interval called an octave corresponds to a vibration-ratio, or pitchratio, of 1 to 2. In like manner, a semitone, which is the octave corresponds to a vibration-ratio- or pitch-ratio, of 1 to 1.059, which is the twelfth root of 2. The number 1.02 is very nearly equal to the 35th root of 2, hence the interval which corresponds to the pitch-ratio 1 to 1.02, is about the 35th part of an octave, or more than one-third of a semitone. This interval is easily perceived by an ear of any musical capacity and training. The writer has proved by experiment that the pitch of a flute pipe is raised a whole semitone by an elevation of temperature of 54 deg. F. This result confirms the above calculation by which a rise of one-third of a semitone was deduced from an elevation of 18 deg. F.

A similar effect is produced on those orchestral instruments (flutes, for example) which are constructed on the same principles as the flute pipes of the organ. When a flute which has been kept in a cool room is brought into a warm room and played upon, its pitch quickly rises, so that it becomes necessary to draw out the extension tube. At first, the air which fills the flute is chilled by contact with the cold instrument, but this chilling does not take place after the flute has become warm.

An interesting observation, confirmatory of the preceding statements, can be made when a band, playing indoors on a cool evening, is accompanied by an "echo" played out of doors. In these conditions the echo always sounds flat, no matter how accurately the echo players have tuned their instruments before leaving the warm concert room.

In orchestral wind instruments, with the exception of flutes, however, the conditions and phenomena are not quite so simple as they are in the case of the flute pipes of the organ. Even in the reed pipes of the organ a complication is introduced by the fact that neither the reed nor the column of air, in general, vibrates freely in its natural period, but the two are brought into forced unison by their influence upon each other. The conditions are still more complex in oboes, clarinets, etc., and also in horns and trumpets, in which the place of the vibrating reed is taken by the tightly-stretched lips of the player. The temperature of the air which is blown into the instrument from the lungs does not vary to the same extent as the temperature of the air of the room. If the latter is 50 deg. F., the former will be about 95 deg. F., but if the temperature of the inhaled air is raised 18 degrees, to 68 deg. F., that of the air expelled from the lungs will be raised only about 3½ degrees, to 98½ deg. F. Hence the effect of variations in the temperature of the room is much smaller with these instruments than it is with the flute pipes of the organ. The effect also varies according to the character of the instrument. For these reasons it is very difficult, if not impossible, to keep an orchestra in tune in an overheated room.

When the cause of the discordance is understood, however, the evil can be obviated to a considerable extent. In the case of the organ it is necessary, in the first place, to keep the air blown into the pipes always at the same temperature. Hence in winter the bellows room should be provided with adequate means of heating, so that the air employed in tuning the organ, when the room in which the organ stands has a temperature of perhaps 50 deg. F., may be heated to about 70 deg. F, the temperature which the auditorium may be expected to attain during the performance.

The best method of keeping the orchestra fairly in tune with itself and with its initial pitch consists in keeping the auditorium as nearly as possible at the temperature which it had at the beginning of the performance, when the instruments were tuned. This result can best be secured by carrying off the excess of heat by means of thorough ventilation. Moderate temperature and pure air exert as favorable an influence upon the physical tone of the instruments as they do upon the mental and moral tone of the musicians and auditors. Hence there are aesthetic as well as hygienic reasons why far more attention should be given to the ventilation of concert halls than this important and difficult problem usually receives.—Prometheus.

THE FREQUENCY OF HEART BEATS IN THE MOUSE.

It is well known that the frequency of heart beats in general is approximately in inverse proportion to the size of the animal. For example, the number of heart beats per minute is 30 in the elephant, 40 in the horse, 50 in the ass and mule, 70 in man, 90 in the dog, 150 to 200 in the rabbit. The difficulty of counting the heart beats when their number exceeds 200 per minute, and the almost insurmountable difficulty of registering them with any apparatus now in use, has hitherto prevented exact measurement of the frequency of heart beats in very small animals. Such a determination has now been made by F. Buchanan, who had been led by theoretical considerations to the conclusion that the frequency of the heart beat in the mouse could not be less than 500 per minute. In order to test the correctness of this conclusion, he recorded the electric variation produced by the contractions of the heart. This he accomplished very easily by plunging the fore feet and the hind feet of the mouse, which was suspended by an abdominal bandage, into two solutions which acted as unpolarizable electrodes and were connected with an electrometer the oscillations of which were recorded by photography upon a moving strip of paper. The number of heart beats per minute was found to be between 520 and 675 in 3 mice weighing about one ounce each, between 720 and 780 in 2 mice eight weeks old, weighing between one-half and three-quarters ounce each, and 680 in a white mouse weighing one-half ounce. The mean value obtained from all the observations was 670 pulsations per minute.

The respiration of mice is also very rapid, 140 to 160 per minute, according to Buchanan's observations. Hence the ratio between the frequencies of heart beat and respiration is about four, as in man and most mammals. The heart of the mouse beats four times as rapidly as that of the rabbit, and ten times as rapidly as the human heart.

TO MAKE LIME WITHOUT A KILN.

IT IS possible to make lime without a kiln, and this method deserves to be more generally known and practised than it is. The proportion of coal used is not greatly increased by the suppression of the kiln, but the time required for burning is prolonged. On the other hand, the cost of the kiln is saved and the cost of transportation can be reduced to a minimum. The proportions of coal and limestone required vary greatly, according to the quality of both materials and the skill of the lime burner. It is always better to use too little coal than too much. In the first case, some of the limestone is left unburned and must be treated again; in the second case, especially if the fire is very brisk, the silicates associated with the limestone may melt and protect a large proportion of the carbonate from the action of the fire. A carload (10 tons) of coal is often sufficient for 50 cubic meters (65 2/5 cubic yards) of limestone.

The first step in the operation is to clear, smooth and slightly elevate in the center a circular area about 16 feet in diameter. A circular pit, about 3 feet in diameter and 20 inches deep, is dug in the center of this flat mound, and connected with the circumference by a trench of the same depth and of the width of the spade. The fire is lighted by means of this channel. The central pit is filled with successive layers of straw, kindling wood and logs, and the whole area is then covered with flat stones for the purpose of preventing the walls of the pit from caving in. Upon the foundation alternate layers of coal and limestone are laid, the latter nearly five times as deep as the former. The pile is made sufficiently tapering to insure stability and is completed by a top layer of limestone. It is then covered with successive layers of flat stones, sod, and mud. In building the pile several air passages are left, on the windward side at the bottom and on the leeward side at the top. The pile is lighted by introducing a torch, fastened to a long pole, through the trench to the straw in the central pit. When the fire is well started some or all of the air passages may be closed. It is even advisable to stop any crevices which may be formed in the outer covering. The time required for burning the pile may vary from a few days to three weeks, according to the quantity of air admitted. It is advisable to conduct the operation slowly, in order to prevent the fusion of the silicates.

PARIS AND ITS TUNNELS.

THE proportions of the disaster which has overwhelmed France, and especially Paris, can hardly be estimated as yet. One-quarter of the city was inundated on January 27th and one-quarter more was rapidly being flooded from sewers, which were backing up as the Seine continued to rise. The loss already is estimated at $200,000,000, and this is called conservative. The Palais de l'Elysee, the residence of the President of France, has its cellars inundated.

In the old Latin quarter, the situation was critical. The sidewalk of the Quai des Grands-Augustins collapsed and fell into the Orleans company's tunnel beneath, further extending the flood through the ancient streets, particularly the rue Jacob and around the Institute of France. Another bad cave-in occurred in the rue de Tournon. Half an hour later the water forced its way up through the subway workings in the rue St. Lazare, which was inundated the whole of its length. In several places the sidewalk fell in. The subway under the Place de l'Opera collapsed.

Many sewers burst in the Twelfth arrondissement, one of the biggest in Paris, the whole of which was submerged. Masons were hastily summoned to erect a wall to save the historic Hotel Lambert, erected in the seventeenth century and now the residence of Prince Czartoryski, and the equally famous Hotel Lauzun adjoining, which was purchased by the city in 1900 to be used as a museum of art. It also was built in the seventeenth century.

The Ile de la Cite, where the famous Cathedral of Notre Dame and the Palais de Justice stand, was changed into a vast lake. The Gare Saint-Lazare stood over a big subterranean lake.

The American and German Embassies were flooded and water poured into the cellars of the British Embassy, the convents and public buildings, including the Pantheon, which was turned into a refuge for the homeless of Auteuil, Alfortville, Maisons Laffitte, Charenton, and other outer sections.

The tunnels of Paris naturally played so prominent a part in this widespread inundation that a description of them may be of some interest.

The lines which compose the Paris Metropolitan are nine in number. Following is a list of the lines in the order of construction: 1. From the Porte de Vincennes to the Porte Dauphine, with a connection to the Porte Maillot. 2. Circular line starting from L'Etoile and following the outside boulevards. 3. Menilmontant to the Porte Maillot. It separates from the two preceding lines at the Rue de Constantinople and passes through the Rue de Rome, the Boulevard Haussmann, the Rues Auber, Quatre Septembre, Réaumur, Turbigo, and Temple. 4. From the Porte d'Orleans to the Porte Clignancourt. This is the north-south transverse line. 5. Boulevard de Strasbourg to Pont d'Austerlitz. It connects the Place de la Bastille to the circular line. 6. Boulevard de Vincennes to Place de l'Italia. 7. From the Place Valhubert to the Quay de Conti. 8. Palais Royal to the Place de la Danube by the Rue Lafayette. 9. From l'Opera to Auteuil by the Place de la Concorde and the Invalides.

All the lines comprise two systems, a number of transverse lines and a circular line, with other short lines connecting them together at various points.

The total length of the first six lines is about sixty miles, forty of which are underground, ten in cuttings, and ten on viaducts. The power is supplied from three stations at Vaugirard, Charonne, and Montmartre. The Place de l'Etoile is a sort of central station. Under its roadway the tracks branch out in all directions.

We will describe L'Etoile-Trocadero line first, as it is the chief of L'Etoile lines. Its track circles around the Place de l'Etoile, so that the trains coming in round the curve and return by a descending line of track, without any switching. This arrangement facilitates the movement of trains and reduces quite considerably the time of stopping at the terminus.

The Porte Maillot-Champs Elysees line traverses Place de l'Etoile and touches tangentially the curve of the preceding line at a point near the Avenue Wagram.

The third line, called the Porte Dauphine-Avenue Wagram line, passes under the other two, and its rail is 46 feet below the surface of the ground. There can be no junction of this line with the Porte Maillot-Champs Elysees line because of this fact, but the stations are built in the same vertical plane, so that passengers can transfer without going to the surface.

The method of excavating adopted was very simple. The contractors dug pits at intervals through which the earth was raised to the surface as the tunnel was excavated. They made as many of these pits as possible, in order to increase the number of working places, and thus decrease the length of time required to complete the work. Some contractors used hydraulic shields, which, notwithstanding their high cost of $24,000, were found to be economical in the long run. By their use the amount of wood-work necessary to hold up the beams of the galleries was considerably reduced.

The shield sometimes took in the whole cross-section of the tunnel, which was then constructed at a single

A SECTION OF THE NEW SUBWAY, SHOWING HOW WALL THICKNESS HAS BEEN SAVED IN CONFINED SPACE BY THE USE OF CONCRETE. IN PLACES THE SUBWAY TRAVELS UNDER NARROW STREETS AND IT IS NOT PRACTICABLE TO EXTEND ITS BREADTH SO AS TO ENCROACH UNDER THE SHOPS OR HOUSES. HENCE THE SIDES AND VAULTING OF REINFORCED CONCRETE.

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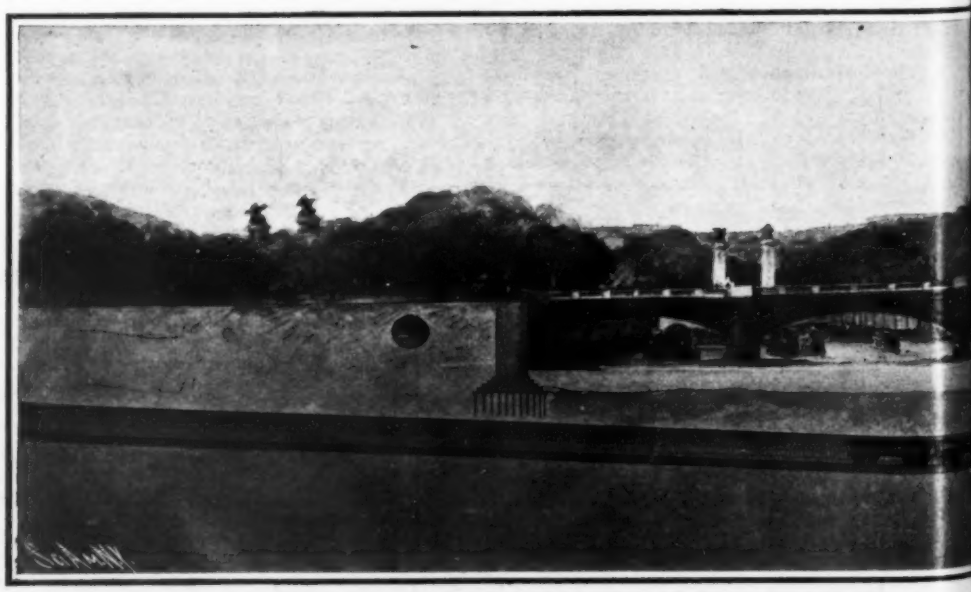

THE PROFILE OF ONE OF THE NEW STEEL TUBES UNDER THE SEINE, THIS IS THE FIRST TIME THAT A TUB... TUBE SECTIONS IS 1,764 AND 1,797 FE... HAS B... TWO TUBES

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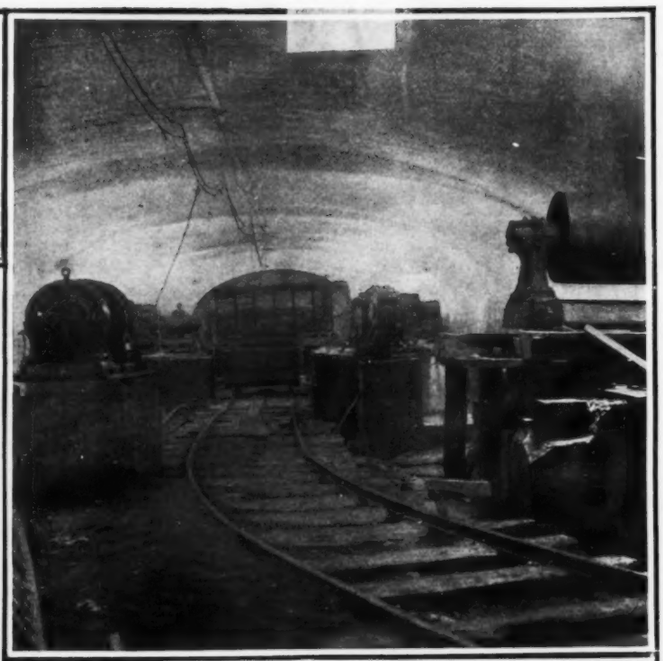

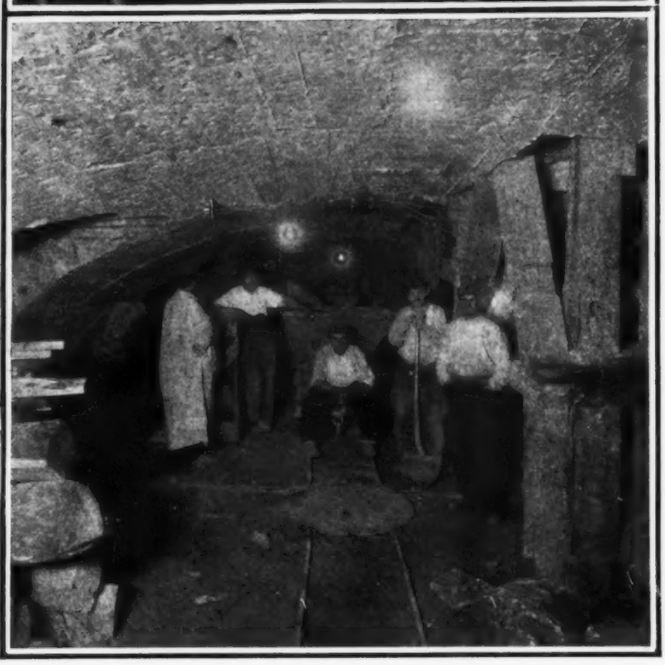

TWO STAGES OF THE WORK OF CONSTRUCTING THE NEW PARIS SUBWAY. THE DISTANCE BETWEEN CENTERS OF THE TWO TUBES VARIES FROM 23 TO 43 FEET. HENCE THE TWO TUBES ARE NOT EXACTLY PARALLEL. THE TUBES WERE RUN UNDER THE RIVER SEINE BY MEANS OF THE AMERICAN SHIELD AND COMPRESSED-AIR METHOD.

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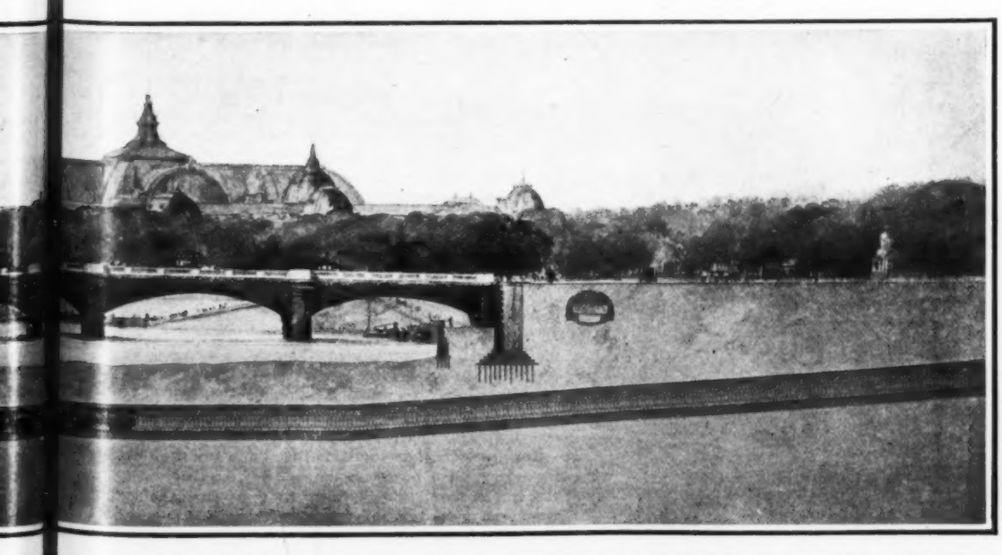

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97 FE TWO TUBES HAVE A SLIGHTLY DIFFERENT PROFILE.

operation, in successive rings. At other times, only the arched roof was cut out with the shield, after which it was necessary to excavate the tunnel down to the level of the roadbed. Whichever way it was used, the role of the shield was not to pierce the earth, but to sustain the roof for the time being. The workmen were placed in front of the shield, where they work with pick and shovel, preparing the way for it. When this had been done the hydraulic rams, which bore against the wood-work of the tunnel, were operated and the shield forced forward, so that the earth was held up by its metallic ceiling. The hole behind it was immediately bricked up.

Unfortunately the shield could not always be used, and there were places where recourse was not to be had to it, as, for instance, in the curved sections.

There are two types of stations. Whenever the tunnel is far enough below the surface, the stations are bricked up, as in the Place de la Nation; but in certain places, as at the Palais-Royal and the Hotel de Ville, water was encountered, and this made it necessary to bring the tunnel as near to the surface as possible.

In the Metropolitan system the Seine is crossed six times, to wit: At Bercy by line No. 6, which has become the prolongation of the circular southern line; at Austerlitz by line No. 5; at City Island by line No. 4; at La Concorde by line No. 8; at Passy by the southern circular line No. 2; and, finally, at Auteuil by line No. 8 for the second time, without counting the crossing, at La Concorde, of the North-South line, conceded to Engineer Berlier. In order to effect these passages, two methods are offered: The bridge known from ancient times, and the subway, the use of which under such circumstances dates back to 1825. Whenever it was not inconvenient to establish viaduct lines bridges were employed.

What was possible at Bercy, Austerlitz, and Passy, where bridges have been widened or constructed, was totally impossible at Chatelet, for instance, where, in order to form the passage of line No. 4 (from the gate of Clignancourt to the gate of Orleans) under the Seine and City Island, the special arrangements were made.

Among such works there is one that has been particularly remarked. In the first place, the Place Saint-Michel and Place Saint-Andre-des-Arts were dug up, and in the trench formed a steel caisson was constructed. In order to pass under the Seine and City Island, there had to be substituted for the ordinary masonry facing of the current type of subway, for a distance of 3,582 feet between Place du Chatelet and Boulevard Saint-Germain, a metallic facing formed of cast iron voussoirs assembled by bolts. In the sub-fluvial parts corresponding to the passage under the small and large arm of the river, the tunnel thus constituted was further incased by sections 132 and 66 feet in length, in metallic caissons of semi-cylindrical form constructed upon the shore, and then transported to the site, ballasted, and sunk vertically until they reached a level such that the distance between the rails and mean level of the water is 36.5 feet. For traversing the land not situated under the Seine, but likewise covered by water, a horizontal tunnel was constructed by means of a shield and compressed air. Recourse was had, in addition, to a very curious process of execution for the passage under the Orleans railway at Place Saint-Michel, that of a preliminary freezing of the ground in order to permit of constructing the Metropolitan line without any danger of the subsidence of the work overhead.

The crossing of the Seine comprised, in addition, the establishment of two stations, one of them at the Flower Market, and the other at Place Saint-Michel. Being destined to rest upon water-soaked ground, these could not be constituted or constructed like ordinary stations. By reason of their excessive dimensions, the possibility of using a shield under such circumstances could not be thought of, and so recourse was had to the use of caissons sunk vertically.

The caisson had the appearance of a coverless box, which in most cases was metallic and with perfectly tight walls, entirely enveloping the work to be constructed, mounted upon the shore when it was to be had to traverse only wet ground, and provided at its base with a working chamber to permit the laborers to prepare the way for the caisson and its contents which they had to let down to a definite level, and which sank progressively by its own weight in measure as the soil was removed.

Each of the stations under consideration, both curved (the "City" of 1,970 feet radius, and the "Saint-Michel" of 984 feet), is composed of three caissons forming a unit 387 feet in length and arranged as follows: In the center, a caisson 223 feet in length containing the station properly so called, and, at each extremity, an elliptical well connecting the station with the subway, of a height equal to the distance existing between a point situated at 8 feet below the lower part of the station and the level of the street, and designed to contain, in addition to a ticket office, a means of access (stairs and elevators) to the passenger platforms. The work at Place Saint-Michel was, therefore done in connection with the construction of the station of that name.

In addition to the Metropolitan there is in construction another subway line. The new road is laid out somewhat upon the same lines as the Paris Metropolitan subway, and makes connection with the latter at different points, so that the cars may shift from one road to the other. This new subway line will run in a north-and-south direction across the city. It will take a district which is not covered by the Metropolitan, and will connect the southern quarter with the central part of the town.

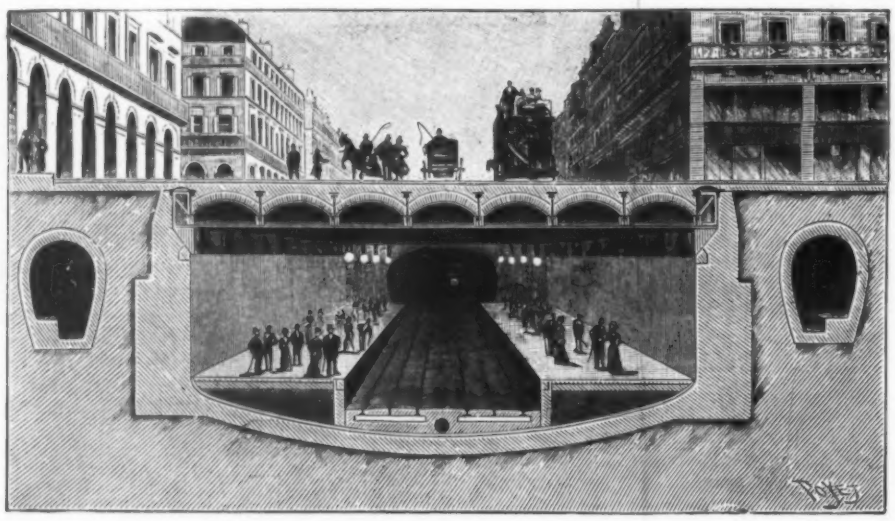
The total length of the line, which is entirely underground, is about eight and one-half miles. It comprises the main line which runs from the Versailles gate, proceeds northward past the Montparnasse depot, then crosses the Seine in tunnel, running thence under the Metropolitan subway and past the St. Lazare depot, finally reaching the northern terminus at the Place Jules Joffrin. At the St. Lazare depot starts a short branch tunnel which passes by five stations and ends at the St. Ouen gate. The main line has twenty-three stations, making twenty-nine stations on the entire route. The tunnel section and the stations are laid out on about the same plan as for the Metropolitan double-track system. There are two special features of the new road. One of these is the steel tube under the Seine and the second the underground stations built of reinforced concrete.

As in the case of the Metropolitan, one of the principal points which occupied the attention of the engineers was that of taking the subway line across the Seine. The engineers ran a tube under the river by the shield and compressed air method, introduced into France some time ago in order to take two large sewers under the river. The general course and the profile of the construction is shown in one of the sectional views which shows the tunnel in its completed state. There is a double tube under the river bed, each tube carrying one of the tracks of the road, which are standard gage. The single tunnel which approaches the river on the south bank, and which is of standard section for double track, ends at a large underground station lying near the river at Rue de l'Universite. At the other end of this station start the two parallel sections of the steel tube. The two tubes are run under the street for some distance and then pass below the Seine in an almost parallel path. Coming to the other bank, the tubes diverge somewhat, and then are brought together and enter a second station. This latter forms the end of the tube section. From the farther end of the station the standard double-track tunnel resumes its course toward the northern part of the city.

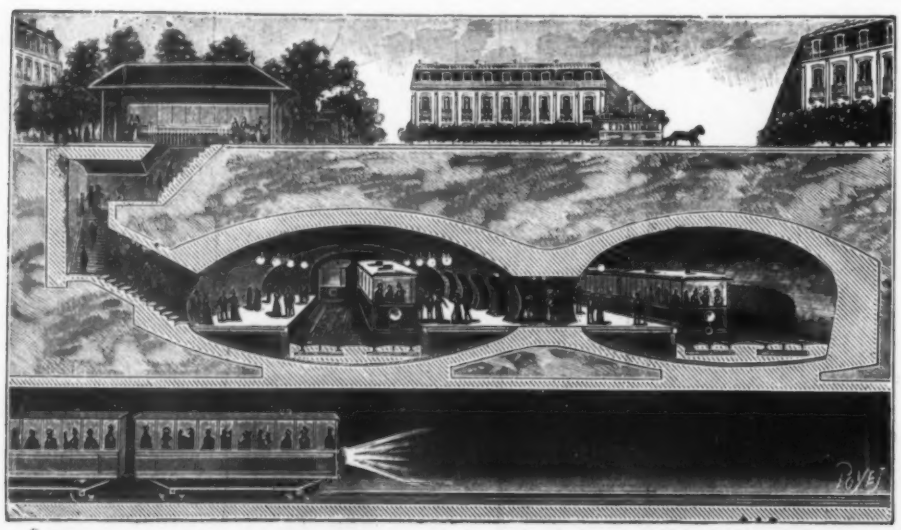
MAP OF THE PARIS METROPOLITAN RAILWAY.

The entire length of the steel tube sections is 1,764 and 1,797 feet respectively between the two stations. The two tubes have a slightly different profile, and the tube lying up stream starts from the Universite station at a down grade of 4 in 100, and on reaching the river the grade becomes nearly level at 1.5 per 100. Toward the other bank the line mounts again at a grade of 3.51 per 100, with a total length of 538 meters (588 yards). The second tube differs very slightly in level, and its length is 548 meters (599 yards). Both of the tubes have an inside diameter of 5.00 meters (16.4 feet) and an outer diameter of 5.24 meters (17.2 feet). The center of the tube is 1.40 meters (4.6 feet) above the rail-level of the track. The tube is formed of a series of cast-iron rings 2 feet broad bolted together by 1-inch bolts through flanges. Each of the rings is made of curved cast-iron pieces forming voussoirs after the manner of arch construction. Around the circumference there are twelve voussoirs, including the key-piece, which is shorter than the rest. There is a space left between the voussoirs of each ring and also between the different rings of the tube of 5 millimeters (0.20 inch), and the space is filled by a thin piece of creosote wood, poplar or pine, on the outer side, the inner part being then filled up with a calking of Portland cement mortar. The thickness of the walls of the tube is one inch of metal in the thinner part, this being reinforced by the webs of the voussoir, which make the total thickness across the web to be 5 inches.

One of the original features of the present plan consists in the use of reinforced concrete for the underground stations. This was required in some cases where the streets were very narrow and the station could not be built in the ordinary way without an excessive cost of expropriation. In order to build the stations without interfering with the walls of the houses, the present method was adopted, and in the case of the Rue de Vaugirard, which is only 15 meters (49.2 feet) wide, an underground station 44.6 feet wide has been built without infringing upon the adjacent property. Instead of 7½ feet for the station wall, the reinforced concrete occupies a thickness of only 2 feet. The vaulting is only 18 centimeters (7 inches) thick, but is reinforced by webs which are designed so as to lie partly on the inside and partly on the outside of the vault.



THE STATION AT THE PLACE DU PALAIS ROYAL.



THE CONNECTING STATION OF THE ETOILE, PORTE DAUPHINE, AND AVENUE WAGRAM LINES. (METROPOLITAN SYSTEM.)

PARIS AND ITS TUNNELS.

THE LOS ANGELES AVIATION MEET.

By CLEVE T. SHAFFER.

THE Los Angeles Aviation Meet, while a wonderful exhibition of flying, to a part of the world in which flying was a novelty, was in fact nothing more than an exhibition. As a meet it lacked the contest spirit manifested when a great number of machines of a diversity of type are brought together, such as at Rheims.

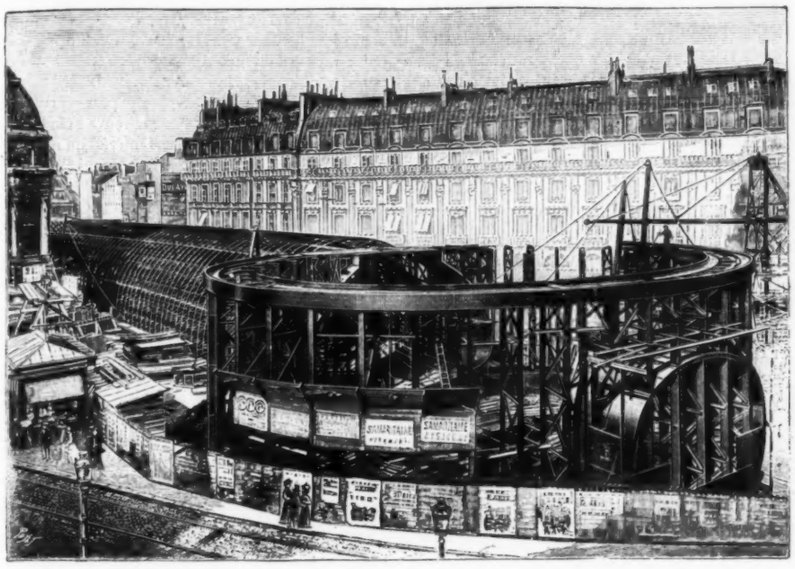
But four aviators qualified and but two types of machines were successfully used—the Farman and the Herring-Curtiss—both biplanes. The Bleriot monoplane made a miserable showing for reasons mentioned hereafter. This lack was also due to the fact that all the aviators present were under contract for a cash guarantee. As a result of this, the meet lost its sporting flavor and consequent zest.

The rules were arranged so that there would be no fixed programme of events for each day, but every day the aviators could try for any of the prizes if they were ready with their machines and found the weather propitious.

With these liberal provisions there was no real excuse for the scarcity of daily flights except that the machines were not capable of more than one or two

short flights a day, or that the operators were simply making exhibition flights, or demonstrating their machines.

The following list of prizes won will give our readers a good idea of what was accomplished by the aviators.



THE END ELLIPTICAL CAISSON WHICH WAS SUNK AT PLACE SAINT-MICHEL.

HEIGHT.

On January 12 Paulhan broke all world's records for height, reaching an altitude of 4,165 feet in his new Farman biplane, which is considerably smaller and over 200 pounds lighter than the regular Farman machine, thus winning the height prize of $3,000. An Aneroid barometer carried by Paulhan registered 4,600 feet, but the figures officially taken were those of the engineering squad which measured the ascent. By this performance Paulhan won the first prize of $3,000.

Chas. K. Hamilton received second prize of $2,000, going up on the last day to an altitude of 626 feet on his Curtiss biplane fitted with a four-bladed propeller. Curtiss received the third prize, of $500. No official height was taken.

SPEED.

In the speed contest Glen Curtiss was, as at Rheims, the winner in his 8-cylinder machine. He won the first prize of $3,000 in the ten-lap-event (16.11 miles), going the distance in 23 minutes, 43 2/5 seconds, an average speed of 40.71 miles an hour.

Paulhan took second prize of $2,000, being over a minute behind Curtiss' time, and covering the 10 laps in 24 minutes, 59 2/5 seconds.

Hamilton received the third prize of $500, his time being 30 minutes, 34 3/5 seconds.

Curtiss made a one-lap (1.61-mile) track record of 2:12, which is a speed of 43.45 miles an hour.

ENDURANCE AND TIME.

Louis Paulhan easily won the endurance and time prize of $3,000, going 75.77 miles in 1 hour, 58 minutes, 32 seconds, a leaky gasoline tank preventing further effort.

Curtiss, on the last day, partially redeemed his lost prestige by making a decided effort to beat Paulhan's record. An accident to his machine caused him to descend after having made 37.05 miles in 1:25:05 (26.1 mile per hour), thus winning the second prize of $2,000. Paulhan was at the same time endeavoring to lower his own record and had the satisfaction of seeing his rival compelled to descend. He followed himself a little later on account of darkness, after covering 40 laps of the course.

Hamilton won the third prize of $500, covering 19.44 miles in 39 minutes, 2/5 seconds (30 miles per hour).

STARTING AND LANDING IN SQUARE.

Willard, in the Aeronautic Society's Curtiss biplane, made a very pretty start and finish in a 20-foot square. Starting some distance back and rising when in the square, he circled around the track and landed with one wheel just an inch off the line, thus winning a prize of $250. In this sort of a trial a brake such as is used on the Curtiss machine is a necessity.

SLOWEST LAP.

This prize of $500 was won by Hamilton, who covered the 1.61 miles in 3 minutes, 36 2/5 seconds. Willard, in a trial for this event, slowed his motor too much and was compelled to drop.

QUICKEST START.

This prize of $250 was won by Glen H. Curtiss, who got off the ground in 6 2/5 seconds from the start of the motor. Curtiss thereby broke his former record. He also broke the world's record (his own) for distance required in starting. The distance to the place where the rear wheels left the ground was but 98 feet. These records were made January 11th.

THREE LAPS WITH PASSENGER.

Prize, $1,000. Won by Paulhan, who covered 4.83 miles in 8 minutes, 16 1/5 seconds (35 miles per hour).

Curtiss carried a passenger several times on his 8-cylinder machine, but did not attempt more than one lap. His passenger seat is placed below and at the left of the operator, and while off center causes no apparent difficulty in manipulation.

Paulhan took up many passengers during the 11 days, sometimes carrying two with ease.

CROSS-COUNTRY FLIGHTS.

The 45-mile cross-country flight to Arcadia and return—22½ miles each way—was a truly wonderful and significant spectacle. A feeling of awe pervaded all who witnessed him gradually disappear into the beautiful background of snowy mountains. His reappearance was no less marvelous, as the tiny speck high in air above the white peaks materialized second after second into man and machine. Prize won, $10,000.

Paulhan made in all four cross-country flights, the three others being unofficial.

The first, from Aviation Field to San Pedro and return, was 21¼ miles.

The third, to Redondo Beach and return, 21¼ miles, was remarkable because of it being a passenger flight, Mme. Paulhan accompanying him. This is a record for a flight across-country with a passenger.

Trip number four was also a passenger flight, in the same direction, with C. B. Harmon on board. The distance was 17¾ miles.

Hamilton, after making his height record on the last day, made a short cross-country flight at about 500 feet elevation, which latter was fortunate, as on his return, while still outside the grounds, his crankshaft broke, his height enabling him to glide into the aviation field without injury.

The dirigibles of Knabenshue and Beachy were brought out every day, but their slow speed and unwieldy bulk limited their maneuvers to hours of good weather.

Beachy made the best time for one lap of 4 minutes, 57 4/5 seconds.

The government dirigible was brought out and inflation attempted, but the gas leaked out faster than it went in, and after about $500 worth of gas had been expended, the attempt was given up. It is claimed that the envelope received injury during the packing or unpacking.

There was an entire lack of interest in the ballooning events, both from the public and the balloonists themselves. As only two outside balloons were entered, the prizes were withdrawn.

The meet was a financial success, the daily attendance being enormous. There were several experiments made in throwing dummy bombs by Lincoln Beachy from his dirigible, and Paulhan from his aeroplane with Lieut. Paul Beck, U. S. A., as passenger. The low elevation at which these attempts were made, however, would seem to preclude the gaining of any valuable information.

Several local machines were tried out but in each case the motor power was insufficient.

THE GREAT CENTRAL CAISSON OF THE PLACE SAINT-MICHEL STATION.

PARIS AND ITS TUNNELS.

THE ERRANT EEL.*

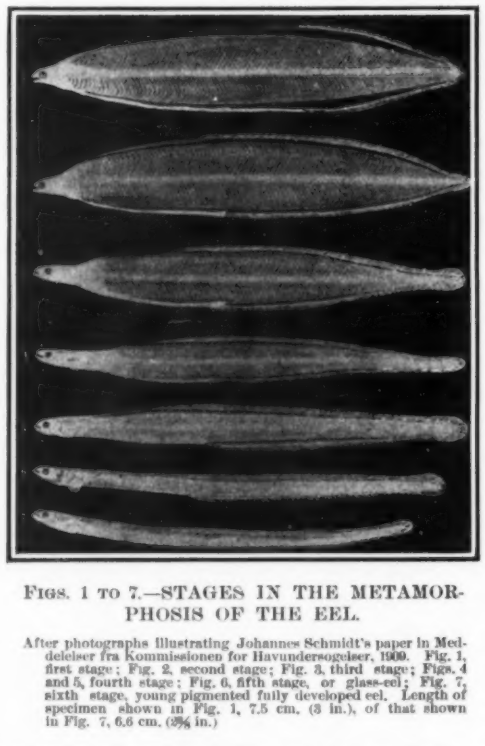
THE TRANSFOMATIONS AND MIGRATIONS OF A STRANGE FISH.

BY J. T. CUNNINGHAM, M.A., F.Z.S.

IT is surprising to notice what a long time it takes for new discoveries about the most familiar things to become generally known and appreciated in spite of the facilities which now exist for the diffusion of knowledge. I have just read in the Daily Mail a letter to the editor informing the public that in the river Severn there is a tiny fish called the elver, which is eaten with pepper, salt, and vinegar, and considered a great delicacy; that it is said by some to be a young eel and by others to be a distinct species, and that being very prolific it is very cheap. It is not difficult to prove that elvers are young eels, and it has been known to naturalists for a long time that in the Severn and other rivers of Europe they ascend in countless multitudes in spring, apparently coming from the sea and traveling toward the upper and more inland fresh waters. From the bank they can be seen in dense swarms passing in continual procession, and the people of the neighborhood dip them out in baskets or hand nets and use them as food. As these slender, flexible, worm-like creatures are able to wriggle their way up vertical surfaces and can live out of water in damp grass, it is easy to understand how not only small streams and ditches, but even isolated ponds and wells may become populated by eels. On the other hand, no adult eels have ever been known to breed in fresh water. The earlier naturalists were unable to recognize their generative organs, and the male organs were first recognized by Syrski at Triest in 1874. The males are smaller than the females, not exceeding a length of 19 inches, while the females may reach a length of 39 inches. The organs of the male examined by Syrski were not in the ripe condition, and with the exception of one male specimen neither males nor females have ever yet been seen with fully developed roes and milts. In the autumn, in places where eels are plentiful, the experience of fishermen shows that there is an extensive migration down the rivers toward the sea, and this conclusion has recently been confirmed by marking specimens in Sweden. One or two very rare cases are known of eels taken in fresh water in which the roes were advanced in development; two of these, taken in Lough Neagh, in Ireland, in January and September, 1895, are preserved in the Museum of the College of Surgeons; considering the enormous numbers of specimens in which the roes are but little developed it is evident that these individuals in a different condition are exceptional and afford no evidence of the spawning taking place in fresh water, although it is a fact that in eels taken in autumn during the downward migration the reproductive organs are somewhat larger than in others. Before the discoveries of recent years had been made, then, it was held as a probable conclusion from the above facts that eels spawned in the sea, and that when the young were sufficiently developed they entered the mouths of rivers and ascended as elvers or eel-fare, while the parents never returned from the sea.

In the course of zoological investigation another clue originally supposed to have no connection with the case has been found to lead ultimately to the solution of the eel mystery. As long ago as 1763 was discovered on the coast of Wales a fish four inches long with small head and transparent, curiously compressed or ribbon-shaped body, which was named Leptocephalus. Since that time other specimens have been taken on British shores which have all proved to belong to the same species, but in the Mediterranean and at the surface of the ocean several other kinds of Leptocephalus were found and were described under different specific names. In 1861 it was first suggested, by Prof. Carus, of Leipsic, that the Leptocephali were the young stages or larvæ of other fishes, but he did not connect them with the eel family. It was the American ichthyologist, Gill, who in 1864 first, on purely anatomical grounds, came to the conclusion that Leptocephali were the larvæ of eels, and in particular *Leptocephalus morisii*, the one first discovered, the larvæ of the Conger. Dr. Gunther confirmed Gill's statements concerning the structural agreement, but maintained that the Leptocephali were not normal stages of development, but larvæ which had been arrested in their development and continued to grow; his reason being that fully developed young conger were often smaller than the Leptocephali. Similar views have been put forward in reference to other larval forms, but have in all cases proved to be erroneous, the reduction in size during metamorphosis having been found to be quite a common occurrence. In the case of the conger the question was set at rest by the actual observation of the transformation of a living Leptocephalus into a young conger; this observation was carried out by M. Yves Delage at Roscoff in Normandy in the year 1886, and the transformation was effected between April 18th and the beginning of July.

The next important step in the progress of these investigations was the identification, among the numerous forms of Leptocephalus which had been distinguished, of the larvæ of the common eel. This was effected by Grassi and Calandruccio at Catania and Messina on the coast of Sicily in the years 1891-2. It has long been known that Leptocephali are more frequently seen and captured on the coasts of the Straits of Messina than anywhere else, a fact which seems to be due to the proximity of deep water and the currents and whirlpools for which the Straits are noted. Grassi and Calandruccio traced in aquaria the metamorphoses of several kinds of Leptocephalus into different species of the eel family or Murænidæ, and although they were not able to follow the whole process in the case of the common eel they satisfied themselves that the larvæ of this species was a form previously known as *Leptocephalus brevirostris*. This



FIGS. 1 TO 7.—STAGES IN THE METAMORPHOSIS OF THE EEL.

After photographs illustrating Johannes Schmidt's paper in Meddeleiser fra Kommissionen for Havundersogeleer, 1909. Fig. 1, first stage; Fig. 2, second stage; Fig. 3, third stage; Figs. 4 and 5, fourth stage; Fig. 6, fifth stage, or glass-eel; Fig. 7, sixth stage, young pigmented fully developed eel. Length of specimen shown in Fig. 1, 7.5 cm. (3 in.), of that shown in Fig. 7, 6.6 cm. (2⅝ in.)

particular form had only been found in the Straits of Messina; it is rather small, not exceeding 8 centimeters (3¼ inches) in length and 1 centimeter in height. The fully transformed young eel was never less than 5 centimeters or 2 inches in length. Besides the larvæ the Italian naturalists obtained specimens of the adult eels with reproductive organs advanced in development, and found that these were distinguished from the ordinary specimens taken in fresh water by larger eyes and by a silvery color. They concluded from this increase in the size of the eyes and from taking eels and deep-sea fishes together that the eels spawn at depths of not less than 200 fathoms. The present writer, commenting on this at the time, pointed out that if it were true for the Atlantic coasts of Europe it would involve a migration of the adults from, say, the mouth of the Elbe to the Atlantic off the west of Ireland, or the Bay of Biscay, and of the young the same enormous distance back again, a journey of about 800 miles each way, while in Sicily such depths occur within a mile or two of the coast. It seemed probable, therefore, that on the west coast of Europe the spawning of the eel might take place at more moderate depths. The recent extraordinary discoveries of the Danish naturalists, however, have proved that eels are actually hatched beyond the 500-fathom line to the west of Ireland or in the Bay of Biscay, and that an eel which may have spent the greater part of its life in the upper part of the Thames or in the Norfolk Broads becomes, when it is sexually mature, a deep-sea fish.

The discovery of the Leptocephali of the eel in the Atlantic by the Danish investigators, in particular by Johannes Schmidt, by whom the actual work was carried out, was not due to accident, but to systematic and reasoned investigation. In the year 1904 the Danish steamer "Thor" was employed in collecting the young stages of edible fishes in the neighborhood of the Faroes and Iceland, which belong to Denmark. This work was undertaken in connection with the International Fisheries Investigations, which have been going on since 1903. The eel, being of great importance to the Danish fisheries, Mr. Schmidt was naturally anxious to obtain specimens of its larvæ, but, although he used large small-meshed nets both at the bottom and at various depths, he obtained only a single specimen of *Leptocephalis brevirostris*, which was taken in May, 1904, near the surface to the west of the Faroes, at a position where the depth was about 650 fathoms. If the young eels which reach the coast in April or earlier were the offspring of adults which migrated to the sea in the preceding autumn it would follow that Leptocephali would only occur in the winter months, but the Italian investigations showed that they occurred throughout the summer. It might also be that the larvæ were not free-swimming, but buried themselves in the sea bottom, but the fact of the single specimen being taken near the surface made this improbable, and it was concluded that the larvæ must be sought in more southern latitudes. Accordingly, in 1905, from May to the end of June, the "Thor" made a voyage from the north southward along the west of Scotland and Ireland, following the 500-fathom line, and Leptocephali were taken in increasing numbers till positions were reached off the entrance to the English Channel, where they were found to be most abundant, as many as 80 being taken in a two-hours' haul. Farther south again above similar depths in the Bay of Biscay few were taken. The larvæ were found to be most abundant at a depth of about 50 fathoms from the surface, but were nearer the surface at night than in the daytime. These results proved that the greatest number of eels spawned in the deep ocean off the mouth of the English Channel, and indicate that the adults in their migration from the coasts bordering the North Sea pass chiefly through the channel to reach the ocean.

In September a few specimens were taken to the west of St. Kilda, and these were found to be in process of metamorphosis. The young eels, after the transformation is complete, are still quite transparent, and they make their way to the coast and enter the rivers. The ascent takes place earlier in places nearer to the Atlantic and also the young eels in such places are more numerous; thus we have the explanation of the elver fishery in the Severn and other rivers entering the Bristol Channel. Similar ascents and similar fisheries occur on the Atlantic coast of France, becoming earlier as we pass from north to south, while, on the other hand, in more northern countries, as Holland and Denmark, the ascent is later, taking place chiefly in April, May, and June. In 1906 the "Thor" made another voyage along the borders of the Atlantic basin to the west of Europe and found the Leptocephali in considerable numbers farther to the south in the Bay of Biscay, but here, as the sea bottom slopes more rapidly, they were captured at a shorter distance from the coast; this was especially the case along the north coast of Spain, where the 500 fathom line is quite close to the coast. In August and September larger numbers of more advanced specimens were obtained, and it was proved that these occur somewhat nearer to the coast than the earlier stages.

The occurrence of eel larvæ has naturally not been so completely followed in the winter months, but the fact that perfectly transparent cylindrical forms occur in the sea a little earlier than the time at which the elvers ascend rivers has been fully established; in the channel off Cape Grisnez Prof. Gilson, at the beginning of February, captured from 100 to 200 at a single haul, and in March and April they have been taken in numbers in the Skager Rack, north of Denmark. From the large number of specimens which have been captured by Schmidt it is easy to trace the course of the metamorphosis, the essential points of which were already known from the work of Grassi and Calandruccio. In Figs. 1 to 7 are shown the successive stages. These figures are copied from Schmidt's photographs which were taken from the actual speci-

* Knowledge and Scientific News.

mens after preservation in formalin; each specimen is of the average size of the stage it represents, so that the reduction in length and height which takes place during metamorphosis is correctly shown in proportion to the size of the figures. The average length of the first stage, shown in Fig. 1, is 7.5 centimeters, or 3 inches; the average length of the fully developed young eel taken in fresh water, represented in Fig. 7, is 6.6 centimeters, or 2⅝ inches; the total reduction in length is, therefore, very nearly 1 centimeter, or 2/5 of an inch. The figures show that no reduction in length takes place until the curious change in the form of the body, in other words the reduction in height, has been very nearly completed. With regard to the actual changes of structure and form which take place in the metamorphosis it will be seen from the first figure, which represents the highest development of the Leptocephalus form, that in this the lateral muscles of the body, consisting as in all fishes of a series of muscle segments or myomeres, are much flattened and extended dorso-ventrally. The anus is far back, the intestine extending along the ventral edge through two-thirds of the length of the body. The vertical fin extends around the posterior third of the body, from the anus round the tail to a point on the dorsal edge a little in advance of the anus. Fig. 2, representing the second stage, shows that the first change consists chiefly in the shortening of the intestine and the corresponding extension of the vertical fin; the changes in this direction are only slightly increased in subsequent stages, the dorsal fin especially extending a little farther forward in the final stage. Figs. 3, 4, and 5 show how the reduction in vertical height of the body takes place, proceeding from the head and tail to the middle. Fig. 6 shows the transparent young eel which is still pelagic and has been taken swimming freely, especially at night, near the surface of the sea. One of the most extraordinary facts about this metamorphosis is that the larvæ take no food whatever during the course of it, a period of eight or nine months. In the fifth or glass-eel stage food has been occasionally found in the intestine and some of these young may feed on their way to the more distant coasts, but the fact that the perfect pigmented stage represented in Fig. 7 is smaller than the transparent stage shows that no growth has taken place, but a continued reduction. Schmidt made a comparison between the average weight of the Leptocephali in stage 1 and of the glass-eels in stage 5, and found that, during the transformation, the Leptocephalus lost over 77 per cent of its weight. It might be that this was merely a loss of water and was due to the consolidation of the tissues, but comparison of the weights of the dried specimens showed that the loss of dry weight was over 32 per cent, so that, although the reduction in size is partly due to contraction of the tissues, there is also an actual consumption of material as the necessary result of so long a period of fasting. The actual weight is indicated by the following figures: On the average 691 Leptocephali in stage 1 weigh a kilogramme, while it takes 3,112 glass-eels in stage 5 to make the same weight, or in English weight a little over 2 pounds.

THE STRUCTURE OF THE VOWEL SOUNDS.

HOW WE SPEAK.

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

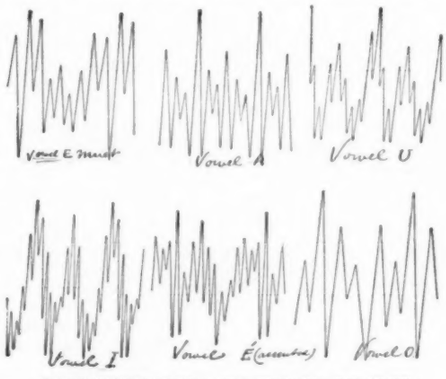
M. DEVAUX-CHARBONNEL, who occupies a prominent position in the Postal and Telegraph Department of Paris, recently carried out a series of researches upon the structure of the human voice. Different scientists have worked in this field. Helmholtz used a series of resonators before which he pronounced the vowels. Hermann used phonographic impressions, and magnified them so as to form the sound waves. Koenig experimented with manometric flames.

The present work was developed by M. Devaux-Charbonnel by means of a telephone transmitter combined with an oscillograph, and the record of the waves obtained in the latter instrument were examined. It is to be noted that the study of the vowel sounds is the most important for understanding the structure of speech, as they play the principal part in spoken language, and it will be observed that the consonants serve only to modify the beginning or end of a vowel in order to form a complete syllable. The vowel sound has the longest duration, and therefore the researches bear especially upon these sounds.

The telephone is found to reproduce the voice, at least for short distances, with great exactness, hence it can be used to advantage. As we now have the oscillograph for registering vibration effect even of a short length, by combining the telephone with the oscillograph we can register the waves of the voice upon the photographic plate. In the method of mounting the apparatus the Blondel oscillograph is used. A moving mirror vibrates under the action of the telephonic currents, and this causes the wave form of such currents to be thrown upon a screen. Owing to the nature of the curves, it was to be supposed that they were made up of a series of vibrations such as a fundamental note and its harmonics, and this in fact proved to be the case. M. Devaux-Charbonnel succeeded in decomposing the complex wave which was obtained for each of the vowels into series of waves, and these are found to be a fundamental note and a series of harmonics, varying according to the nature of each vowel. In order to carry this out, he took photographic plates for each vowel sound and enlarged these by projection so that he could obtain curves of 20 inches height. The structure of the vowel waves was thus easily seen. In order to decompose the vowel wave into its harmonics, he proceeds by a method of elimination.

Thus the real structure of a vowel sound is readily observed, and he finds some interesting points in this way. The fundamental note is seen to be of a less intensity than the various harmonics. Taking the case of the vowel A, where the fundamental note is represented as unity, the second harmonic has a value of 1.7, the fourth harmonic 3.0, and the sixth harmonic 4.8. Here the sixth and the fourth harmonics are predominant, while the fundamental and the remaining harmonic are much less prominent. For the vowel O, the fifth harmonic predominates, and has about four times the value of the fundamental note. For the vowel I, the second harmonic has about four times the value of the fundamental, and the 13th harmonic has nearly three times the value. It is natural that the vowel I should contain sharper sounds, that is, higher harmonics than the vowels A or O, and this is seen to be the case here.

Another interesting point which is observed is that according to the above analysis of the waves, each of the vowel sounds generally contains a note which is more prominent than the others of the series. The vowel is therefore characterized by this note. Taking the fundamental note to be 160 vibrations per second, such as was observed in the present case for each of the vowels pronounced by a male voice, the most prominent wave in the vowel O is the fifth harmonic, and as above noted, this is four times as strong as the



THE STRUCTURE OF VOWEL SOUNDS.

These are the vowels of the French language. A, as in "palm". É (accented) as in "met". E (mute) as in "water". I, as in "feel". O, as in "old". U, nearly equivalent to the German "U".

fundamental. As the latter has 160 vibrations per second, the fifth harmonic will have five times this number, or 800 vibrations per second. The note which corresponds to this number of vibrations is therefore prominent in the vowel O. In like manner the vowel A is characterized by a note which corresponds to 960 vibrations per second. For the vowel I, the second harmonic, corresponding to 320 vibrations, is the strongest, but very near this value lies the thirteenth harmonic, which gives a note of 2,080 vibrations per second. It is the presence of this high note which gives the sharper sound which we observe in the vowel I, while the vowels A and O do not contain a note which is nearly as high as this, as might be expected from their lower or graver sounds.

The values for the characteristic notes of each vowel are nearly in concordance with what were obtained by Helmholtz, Koënig, and the other experimentors mentioned above. This is due to the fact that in general the range of the male voice as regards speech lies at about the same value, this being near 160 vibrations per second. It must not be supposed, however, that each of the vowels has a certain pitch or fixed note which characterizes it, as might be supposed where the form of the wave could not be clearly observed. By the preceding examples it seems to be evident that the characteristic note is not separate and distinct, but is a harmonic of the fundamental note in each case. What is therefore striking in the researches seems to be the fact that each of the vowels contains a fundamental note of about 160 vibrations per second, together with various harmonics whose presence and value change with the different vowels, and that some of the harmonics may be much stronger than the fundamental note, so that they appear to make up the greater part of the vowel sound for each particular case.

In the above experiments the vowel sound was given before the telephone in a continuous manner, and this in fact somewhat resembles a musical sound, as it has a regular form. However, in ordinary conversation the vowel sounds are not pronounced in this way, but are combined with the consonants. It was therefore desired to find the effect of spoken syllables. To register these, a moving film was substituted for the fixed photographic plate. The film rolled upon a cylinder placed at one end of the opening so that a flat portion could be moved across the path of the waves for a certain time, say one second, and we can now register the waves for several syllables. By pronouncing a series of vowels in succession, A O I E, for instance, we find that each vowel is composed in its main part of the waves which we observed above, but there is also an initial and a final period for each vowel, in which the sound increases or again diminishes. This period contains four or five vibrations.

As to the effect of consonants upon the waves, the presence of the former (which give an irregular trace) modifies the wave of the vowels during four or five periods. Each of the consonants has a different effect upon the vowel wave, but the vowel is generally not modified for more than the above-mentioned amount. It is found that speech is thus not an exactly regular periodic phenomenon, but it is composed of regular (or wave) periods which are placed between quite different phenomena which are caused by the passage from one vowel to another, but these irregular periods are of comparatively short duration. It is observed that not more than 5 or 6 syllables per second can be clearly emitted by the voice, and above 10 syllables per second the words are no longer intelligible. For an ordinary male voice whose fundamental note corresponds to 160 vibrations per second, a single syllable will take in about 30 vibrations or periods. Of this number, there will be more than 20 which correspond to the vowel sounds alone and which show a very regular character. For the ear, this part is the most prominent one of the phenomenon.

To sum up, we conclude that the human voice is to be recognized as a sound rather than a noise, that is, that the voice is formed of a succession of vibratory phenomena whose greater part is of a regular vibratory character.

The above considerations relate to the general theory of speech, but M. Devaux-Charbonnel considers that they will throw light also upon the question of telephonic currents, and he expects to make further researches upon their use in the field of telephone work in connection with instruments and telephone lines.

The United Railways and Electric Company, of Baltimore, Md., has put into use a system of oiling the motor bearings of all revenue cars on a mileage basis. Motors are oiled at the division car houses on instructions from the office of the superintendent of shops, where all records of mileage are computed. Mail, express, maintenance of way, and special parlor cars are not included in the plan, nor are snow plows and sweepers. The system is not intended to supplant the previous practice of having car-house foremen follow closely the mileage of the cars in their charge, but it is believed it will relieve those divisions where the work of computing the mileage daily has proved too great a task, and will result in better economy and efficiency of lubrication on the whole system.

THE WORLD'S SUGAR SUPPLY.*

SUGAR CANE AND BEET.

BY GEORGE T. SURFACE, PH.D.

THE problem of sweetening humanity physically is only second to that of sweetening it temperamentally and socially. What was an efficacious medicine prior to the tenth century became through the increased quantity and the cultivated taste a delicate luxury from the tenth to the sixteenth century; and thereafter began to be a staple food in certain parts of the world. In medieval times the peasants could only partake of sugar occasionally at special feasts, and the privilege was so coveted as to make the sugar-eating days loom up as bright spots on the mental horizon to lighten the burden of grinding poverty and every-day toil. The sixteenth century ushered in a new epoch of industrial development in which sugar was destined to play the most conspicuous part during at least a century. The islands of the West Indies and the tropical coasts of the Americas seemed to be but waiting for the transplanting of the cane and the introduction of the negro. The sugar industry and the slave traffic fitted into each other so perfectly, that throughout the colonial exploitation of slavery the sugar industry was without a peer in the international trade. As late as 1830, more than half of the world's sugar crop was produced by slave labor, and with the emancipation of slavery the tropical sugar industry suffered a depression from which it did not rise until it rose to find a dangerous competitor in the sugar beet of the temperate zone.

The sugar production of the world continues to increase more rapidly each year, and yet the demand is economically greater than the supply. During the past quarter century the world's production has been doubled. In 1888, the total production of all countries was 7½ million tons and in 1908, the production was more than 14 million tons. In this interval the per capita consumption in the United States rose from 50 pounds to 83 pounds, an increase of 65 per cent. The only country exceeding the United States in the great sugar-eating contest is Great Britain, whos record last year was almost 90 pounds for each man, woman and child. The enormous consumption of sugar in these two countries presents the anomaly of comparatively small producers being the largest consumers. It must be remembered, however, that the taste for sugar is far more natural than acquired, and intensifies itself with the ability to pay the price. Denmark and Switzerland are the only other countries of Europe consuming as much as 50 pounds per head, and the general average for all Europe is about 24 pounds per head. Germany, the greatest sugar-producing country, consumes only 42 pounds per head; and Belgium, the little industrial giant of the continent, consumes only 24.4 pounds per head, which is 45 per cent less than the German consumption. The variation in the amount of sugar consumed in the same country and in different countries finds its explanation in the cost of the commodity, the wages of the consumer, and the native food-stuffs. The retail price of sugar in Naples and Milan is 13½ cents per pound, which is almost three times the London price; but the average wage of the unskilled laborer in Italy is but one-third to one-half that of the corresponding English laborer. In addition, the greatest poverty in Italy exists in the south, where the food must consist largely of sub-tropical fruits and vegetables in which sugar is an important constituent. We need not, therefore, be surprised at the fact that the average sugar consumption in Italy is 8.3 pounds per year, purchased at a cost of $1.12, or four days' labor; while the more fortunate Englishman purchases with the same amount of labor, 75 pounds of sugar. The Austrians consumed only 24 pounds per year, but the retail price is 7 to 8 cents per pound, and the average wage less than one-third that of the Englishman, and one-quarter that of the American.

Poverty makes necessary the purchase of the cheapest foods to the end of supplying a sustaining quantity, and as starch foods are cheaper than sugar throughout the world, the poorest classes in all countries show their preference for them. It is a fortunate coincidence that a large consumption of starch foods makes a corresponding consumption of sugar unnecessary, since starch and sugar belong to the same chemical family. It is obvious that all classes with a sufficient income to purchase a diversity of foods consume more than the per capita average, and that the wealthiest are the largest consumers.

The phenomenal increase in the demand for sugar is in part attributable to a gradual change in the opinion of medical and scientific students concerning its relative value as a food. When the medical profession was based upon one and two years of indifferent investigation, the idea generally prevailed that sugar was a dangerous, indigestible compound, and the specific cause of many fatal, organic diseases. To those who could not afford to purchase it, this was the most convenient excuse for a minimum consumption, and in many rural communities is as strenuously advocated to-day as it was fifty years ago, when the cost of sugar was more than double. In the light of modern physiological and pathological research, it seems conclusive that the dangers from an excessive use of sugar differ but little from those attending an excessive use of proteids or fats, and that sugar is as essential to a well-balanced ration as any other class of nutrients. In the production of heat and energy the proteid or nitrogenous foods and sugar are of about equal value, and it is claimed by some experts that the nitrogen retention from proteid foods is increased at least 25 per cent if consumed with sugar. The horror of succumbing to kidney or liver diseases if sweets are indulged in is passing, as a result of which many, and perhaps all, are indulging in those sweets more freely. In the wisdom of moderation an excess is to be avoided, since it must result in indigestion, which in its various forms is the mother of most of the ills of humanity.

SUGAR CANE ERA.

Cane was without a successful rival in the production of commercial sugar until the middle of the nineteenth century, when Germany and France began a vigorous and persistent development of the beet sugar industry. Limited quantities of maple sugar were manufactured in America and Europe and date sugar was a popular sweet in China, but neither had an appreciable effect on the sugar market. That the beet sugar industry as late as 1836 was still in its experimental stage is evidenced by the fact that, in that year, the total production in France and Germany was less than 3,000 tons. England imported in this year 200,000 tons of cane sugar from the West Indies and 10,000 tons from the East Indies, which represented about one-half of the total world production.

In the seventeenth and eighteenth centuries the Dutch East Indies (Java, etc.), Spanish West Indies (Cuba, Porto Rico, etc.), British West Indies (Barbadoes, Hayti, etc.), Canary and Madeira Islands (under Spanish and Portuguese), and Brazil (under the Dutch) became the great cane growing regions for the European and American sugar supply.

The cane growing countries, in the order of production in 1908, are: British India, 2,046,000 tons; Java, 1,156,000 tons; Cuba, 961,958 tons; Hawaiian Islands, 465,288 tons; United States, 50,000 tons; Porto Rico, 200,000 tons; Queensland, 188,000 tons; Brazil, 180,000 tons; Mauritius, 170,000 tons; Philippines, 135,000 tons, and all other countries, 1,000,000 tons.

On the basis of value, 93 per cent of the sugar imported into the United States is cane sugar. The total cane sugar imports last year were valued at $125,800,000, distributed as follows: Cuba, $58,000,000; Hawaiian Islands, $40,000,000; Porto Rico, $19,000,000; Dutch East Indies, $11,000,000, and the Philippine Islands, $699,000. This means that, excepting British India and China, where the crop is consumed locally, the United States consumes 60 per cent of the world's cane sugar crop.

THE FUTURE OF CANE.

In the light of present development the future of the cane sugar industry is somewhat problematical. The beet sugar industry is increasing more rapidly than the rate of consumption, and the competitive conditions in the cane growing countries are becoming more difficult each year. Twenty years ago cane sugar constituted two-thirds (66.2 per cent) of the total world supply, while now it constitutes one-half; and yet in that period the total production was doubled. The cost of producing raw sugar is increasing in the leading cane growing countries, and the cost of producing beet sugar is diminishing through improvements in seed selection, cultivation, and machinery. It costs more than 2 cents to produce a pound of cane sugar in Cuba, and a little less than 2 cents to produce a pound of beet sugar in Germany. But Austria and Holland are making beet sugar at even a less cost than Germany. The cost of production in the United States is from 2½ cents to 3 cents per pound, which would indicate that the survival of the domestic industry has a vital dependence on the equalizing effect of import duties.

The present cane production in the United States is about equivalent to the annual average during the past 15 years, which is convincing evidence that but little pressure would be required to bring about a decline in the cane sugar industry in this country. Not only is the cost of labor increasing in the Gulf States, but the profits from trucking, fruit growing, cotton and rice are increasing with the urgency of the demand.

THE RISE OF THE SUGAR BEET.

The economic production of sugar from sugar beets has solved successfully the problem of meeting the growing demand for this popular and valuable food. The nations of the temperate zone are the great sugar consumers of the earth, and the sugar beet is strictly a temperate zone plant. Like many other profitable industries, it developed slowly in its early stages, but is now progressing at a rate which is truly alarming to the countries whose chief source of revenue has been the cane sugar industry. The phenomenal increase in production is due to the growing demand for sugar, the profits realized by the grower and the manufacturer, the wide climatic and soil adaptation of the crop, and the steady increase in the amount of sugar contained in the beet. In 1885, the beet crop of France had 7.83 per cent sugar, and the German crop averaged 12 per cent; as compared with 12.6 per cent in France, and 17.5 per cent in Germany in 1908. With this record it is not surprising to find that Germany increased her beet acreage from 600,000 acres in 1885 to more than 1,000,000 acres in 1908; and her sugar output from 850,000 tons in 1885 to 2,223,000 tons in 1908.

IMPORTANT BEET GROWING COUNTRIES.

Beets have been successfully grown for the manufacture of sugar in all of the continental countries of Europe, and in the United States and Canada. The latitude zone may be said to extend from 45 deg. to 58 deg., according to the general climatic conditions. Most of the beet producing countries have a mean annual temperature of 55 deg. to 65 deg. F. The Department of Agriculture has defined the economic beet zone for the United States, as a belt 100 miles in width on either side of the June, July, and August isothermal line of 70 deg. F. The moisture supply is of paramount importance with temperature; and since it is almost impossible to obtain a distribution of rainfall ideally adapted to the crop, the most satisfactory results are realized under irrigation.

Europe had last year 4,860,000 acres in beets, which produced 7,041,000 tons (2,204 pounds) of sugar. Of this enormous sugar crop Germany had 2,223,521 tons, more than one million tons of which were exported. The largest producing provinces in Germany are Saxony, Brandenburg, East Prussia, and West Prussia. Saxony has long taken the lead, with Magdeburg as the great manufacturing and refining center, but the present tendency is toward the shifting of the center to Prussia.

Austria-Hungary is the second largest beet grower, with 816,000 acres and a sugar production of 1,409,000 tons. There are 119 sugar factories in Bohemia, 61 in Moravia and Silesia, and 24 in Hungary. Sixty per cent of the total crop is exported to the various sugar importing countries of Europe.

Russia ranks first in acreage (1,386,996), and third in production (1,403,300 tons). These figures are a sufficient commentary on the inferior methods of cultivation in vogue. Russia has a continental climate which subjects the beet crop to great risks, but no other country possesses so large an area on which beets of average sugar content can be matured. The domestic industry has had the effect of increasing the domestic consumption. In 1850 the consumption in Russia was about one-half pound per head, as compared with 17.6 pounds in 1908.

France, the most enthusiastic of European nations in the early development of the industry, is not keeping pace with the other important beet growing countries. Her production in 1908 was 719,900 tons, manufactured by 255 factories. The French have made less progress than the Germans and the Austrians in the development of beets of high sugar content, the average in France being 12.6 per cent, in Austria 17.2, and in Germany 17.5.

Proportionate to area Belgium is the largest beet sugar producer in the world, one hundred and forty thousand acres producing 231,000 tons. On account of the size of the country and density of the population it is impossible to appropriate a much larger acreage to beets.

Holland cultivated 120,000 acres, giving a production of 173,000 tons. The crop is manufactured by 28 plants, many of which are also engaged in refining the

*Yale Scientific Monthly.

raw sugar imported. The cost of production in Holland is about 1.5 cents per pound, which is lower than in any other beet growing country. The retail price is 9.4 cents per pound (Amsterdam), the result of the high consumption tax of 4.6 cents per pound.

Italy is the next largest producer in Europe, having an output in 1908 of 150,223 tons. Although limited areas are adapted to the cultivation the Italian production is being steadily increased. Here the consumption tax is highest, 5.7 cents per pound, and the retail price highest, 13½ cents (Naples and Milan). The poverty of the masses, and the high price make a small consumption imperative, 8.3 pounds per head.

Sweden has expanded the industry to 109,500 tons, which so nearly satisfies the domestic demand that the total sugar and molasses import in 1908 was only $16,654. The cultivation of the beet is concentrated in Scania, with manufacturing centers at Helsingford and Kzeflinge.

There is a limited production in Spain, Denmark, Roumania, Switzerland, Bulgaria, Greece, and Servia.

STATUS IN THE UNITED STATES.

The first permanent beet sugar factory in the United States was constructed in 1870 at Alvarado, Cal., 32 years after the government made its first favorable report on the possibilities of the industry. Unfortunately the first experiments were conducted in the humid States of the East, which produced beets low in sugar. The development was slow but steady following 1870. In 1892, we had only six factories in operation and a total production of 13,000 tons of sugar. With the passage of the Dingley Bill of 1897 the industry was inspired with a new life, resulting in the construction of fourteen new factories in 1899. The growth of the industry since 1897 is a record unparalleled by any other beet growing country, having increased from 40,000 tons (1897) to 420,000 tons (1908). From 1890-1908 the cane sugar production in the United States increased scarcely 10 per cent, while the beet sugar production increased from 2,223 tons to 420,000 tons. The acreage has been more than doubled since 1901, and the production has been more than doubled since 1904. Sixty-five factories are in operation in sixteen States, Colorado and Michigan leading, each with sixteen. The important beet growing States in the order of production are: Colorado, California, Michigan, Utah, Idaho, Wisconsin, Kansas, Montana, New York, and Minnesota. California, Michigan, Wisconsin, and Idaho lead in crops of highest average sugar content.

The total beet and cane sugar production in the United States supplies but one-fifth of the domestic consumption. On the estimate that our laboring constituents receive an average of 3 cents per pound in the production of home-grown sugar, $167,000,000 would be added to the pay-roll, if the production were equal to the consumption. Can we anticipate such a development with hope? Why not? The Department of Agriculture estimates that the United States has 274,000,000 acres adapted by soil and climate to the cultivation of beets, and that if this area were cultivated in four rotation crops, beets constituting one, the annual sugar production would be 15,000,000 tons. The domestic demand would be supplied by the cultivation of 1,500,000 acres, if the crop only averaged eight tons per acre. The average price paid for beets in 1908 was $5.35 per ton, as compared with $4.10 in 1897. The profits have been so satisfactory in the irrigated regions of the West that the price of land adapted to beets has increased since 1905 from 20 to 60 per cent more than the same grade farms not adapted to beets. The factories have also flourished, as evidenced by the construction of more than fifty from 1900 to date. The total capital invested is conservatively estimated at $70,000,000.

FLUCTUATION IN CONSUMPTION.

The amount of sugar consumed varies with the financial situation and the price of the commodity. From 1890 to 1900 the country experienced a general financial depression, as a result of which sugar became a luxury to the poorer classes. During this period the consumption increased from 51 pounds per head to 58.8 pounds, an increase of 15 per cent. From 1900 to 1907 is recognized as a period of unprecedented business prosperity, and the sugar consumption increased from 58.8 pounds to 82.6 pounds, an increase of 40 per cent. In the interpretation of these statistics it should be remembered that from 1890 to 1900 the average price of refined sugar on the New York market was less than the average price from 1900 to 1907.

A FORERUNNER OF COPERNICUS.

FORGOTTEN NICOLE ORESME.

BY PROF. PIERRE DURHAM.

In the year 1368 Albert von Helmstaedt, better known by the name of Albert de Saxe, a celebrated master of the Faculty of Arts of the University of Paris, wrote a commentary on Aristotle's Treatise on the Heavens and the Earth. One of the questions propounded in this treatise is "whether the earth, placed in the center of the universe, is continually at rest or continually in motion." In regard to this question Albert asserts that "one of my masters appears to profess" that it is impossible to demonstrate that the movement of the earth and the immobility of the heavens are incompatible with the observed phenomena. Albert then proceeds, with all respect to his master, to demonstrate this incompatibility by the orthodox methods of the schoolmen. The interesting point in all this is the evidence furnished of the existence, in the middle of the fourteenth century, of a professor of the University of Paris who regarded the rotation of the earth even as a possibility.

Although this unnamed and unknown master did not convince Albert de Saxe, he appears to have had better success with another student who attended lectures at the university about the same time. This student was Nicole Oresme, of Bayeux, who came to Paris in 1348, to study theology, and in 1356 became grand master of the College of Navarre. In 1362, after having obtained the degree of master in theology he was appointed a canon of Rouen, and two years later he was promoted to the rank of dean of the chapter. He was created bishop of Lisieux in 1377 and died in that city in 1382.

Oresme was endowed with remarkable mental activity, and wrote a great number of works, some in Latin and others in French, in a style that made him one of the acknowledged masters of that language in the fourteenth century. His treatise on money and coinage, written both in Latin and in French, exhibits him as a pioneer in the science of political economy, and Curtze has shown that Oresme, in a brief mathematical tract, forestalled Descartes and Ferneat in the invention of geometrical coordinates.

The reigning king of France, Charles V, was desirous of disseminating among his subjects the knowledge that had been restricted to scholars acquainted with Latin. In pursuance of this design the king appealed to the dean of Rouen, to whom he had already given many tokens of his confidence and esteem.

Oresme had already written in French a "Treatise on the Sphere, designed to teach the form and arrangement of the world, the number and order of the elements and the movements of the heavenly bodies, to every man of free condition and noble mind." The king now commissioned him to write French translations and commentaries on some of Aristotle's works. In 1370-1 Oresme translated Aristotle's Ethics, Politics and Economics. These translations and commentaries were printed in the 16th century. Oresme also wrote a translation, with extensive commentaries, of Aristotle's Treatise on the Heavens and the Earth. This work has never been printed, but several manuscript copies are in existence. One, in the possession of the Bibliothèque Nationale, is adorned with miniatures and bears the signature of the Duc de Berry, brother of Charles V.

In the second book of the Treatise on the Heavens and the Earth Aristotle proves, to his own satisfaction, that the earth remains motionless in the center of the universe. After translating this section Oresme proceeds to give his own opinion, "subject to correction," that the earth revolves daily on its axis and that the heavens are motionless. He develops this opinion at great length and clearly and ingeniously shows the fallacy of the arguments urged against it—for example, that the rotation of the earth would not account for the rising and setting of the sun, moon, and stars, that it would necessarily produce a mighty east wind (the air being assumed to be left behind), and that a stone thrown vertically upward would strike the ground to the west of its point of departure. Oresme takes the example of a ship moving very steadily eastward and shows that, to an observer on board that ship, a motionless vessel would appear to be moving westward, and that it would be impossible for such an observer to decide which of the two vessels was moving. He explains that the atmosphere moves with the earth as air confined in a closed vessel moves with the vessel, and that a stone thrown vertically upward also moves with the earth, both in ascending and in descending, so that it necessarily returns to the point from which it was thrown. Hence he concludes that it is impossible to prove by experiment that the heavens move and the earth remains at rest.

After having thus shown the futility and fallacy of the appeal to experience, Oresme proceeds to refute the religious, metaphysical, and astronomical arguments in favor of the immobility of the earth. Here it becomes uninteresting and tedious to follow him. The same remark applies to his support of his own opinion by positive arguments, of which some are sound and ingenious and others metaphysical and absurd. One argument is rather amusing. Oresme says that if one thing receives benefit from another it should obtain this benefit by its own movement. Hence the earth, in order to receive the heat and light of the sun in all its parts, must rotate on its axis, instead of requiring the sun to revolve around it. Thus the roasting joint turns on the spit before the fire, but the fire does not move around the spit.

Did Copernicus possess any knowledge of this dissertation in favor of the daily rotation of the earth? It appears impossible to give a decisive answer to this question. Master Nicole Oresme's commentary on Aristotle's work, written in French, at the king's command and cost, by one of the most important members of the University of Paris, should have had a great vogue in France, but the fact that it was written in French probably prevented its becoming widely known among foreign scholars. It is a very remarkable fact that this one work has never been printed, although the Treatise on the Sphere, which was often appended to it in the manuscripts, in accordance with the author's expressed desire, was printed in the sixteenth century. Hence it is very possible that Copernicus was ignorant of the existence of Oresme's work.

On the other hand, the arguments advanced by Copernicus, in his treatise *De Revolutionibus Orbium Coelestium*, in support of the possibility and probability of the daily rotation of the earth, so strongly resemble Oresme's reasoning, that this part of the great work of Copernicus might well be taken for a concise and somewhat obscure *résumé* of the corresponding portion of Oresme's commentary on Aristotle's Treatise on the Heavens and the Earth.

At all events, it is certain that the work of Nicholas Copernicus was anticipated, even if it was not inspired, by that of Nicholas Oresme.—Translated for SCIENTIFIC AMERICAN SUPPLEMENT from Revue des Sciences Pures et Appliquès.

AN AFRICAN ELEPHANT FARM.

ONE of the great obstacles to agricultural development in the equatorial districts of Africa is the difficulty of procuring beasts of burden. Horses have been tried in vain; oxen soon become useless; the ass would no doubt be a serviceable animal, but it is difficult to acclimatize; while zebras, in spite of many attempts that have been made to break them in, have never been domesticated to any serious extent. In these circumstances some interest may be felt in an experiment which is being carried on by Commandant Laplume at Api, in the Congo Free State, and of which some particulars are given by M. Daniel Bellet in Cosmos. The African elephant has been generally considered as quite intractable; but Commandant Laplume is of opinion that much may be done with him if caught young. The catching takes place during the dry season. A party is made up, who set out to look for the fresh spoor of elephants. They only follow those tracks which indicate that the herd contains calves of the right age to undergo training. As soon as the herd is sighted, guns are fired to frighten the animals and send the old ones flying. The calf also runs or tries to run, but its slowness permits the hunters to catch it up. A rope is passed round its neck, a second round its body behind the fore legs, and then a third attached to the two others. Three or four men walk in front, holding one end of the last rope, while the other end is held behind in the same way. It is necessary to take the greatest care to prevent the animal being injured by the ropes in any way, as even slight wounds are very dangerous to the calves, and they are brought in to the farm as tenderly as possible. The task of catching has been materially lightened of late, because several of the elephants, captured in former years, have been trained to assist the hunters.

In spite of all precautions, however, the losses are

considerable. From January 4th to March 5th, 1909, the Commandant, accompanied by 21 black hunters and 15 rope-men, captured 33 calves, but 15 had to be released at once, as they were not suitable, and 7 died.

Although the director of the farm has had great experience of this work, the death-rate among the calves is very high. They die of hæmaturia, dysentery, pining, and sunstroke; while some, as soon as they are captured, lie down and refuse to eat as though they were broken-hearted.

The training at Api is conducted in this way. The driver begins by putting himself on good terms with the elephant; then he mounts her in the stable; he probably gets a few falls, but apparently without any serious harm. The next step is to put on some simple harness, by which two baskets may be carried on either side, and these are filled with loads. After this a breast band is used, and the elephant begins to draw a light tree trunk, then a little cart, and finally a heavy wagon.

In the case of carts and wagons the animals are generally harnessed in pairs, but for ploughing they are driven singly. They can get through a great amount of work. Recently the assistant manager of the farm took two elephants to fetch a wagon from a distance of 600 kilometers. They crossed the river Wille twice without any difficulty, although it was from 500 to 600 meters wide. The elephants can also be used for riding, carrying the baggage as well as the rider; they travel at a rate of five kilometers an hour for about five hours, but they ought not to be worked in the full heat of the sun. Doubtless the training, and especially the capture of a herd costs a lot of time, trouble and money, but the animals live to a good age and can work for many years. The farm at Api now owns some 50 trained elephants.

ENGINEERING NOTES.

According to a despatch to the daily press, the electric station at Skabersjo, Sweden, has been operating for the past five years on gas made from peat. The despatch further states that the station has a fuel supply for 30 years in a bog of 37 acres, in which the peat is five feet deep. Two 150-horse-power generators are coupled direct to two gas engines, which receive peat gas from two suction gas producers. The current is conducted about three miles to Svedala, and used for street lighting and power for several small industries. The cost to consumers is about one-half cent per horse-power-hour. Only tar is saved from the waste, but recent experiments indicate that in a somewhat larger station the sulphate of ammonia and other by-products may be made to pay all gas-production expenses.

The Journal of Industrial and Engineering Chemistry contains the result of an important investigation by Messrs. Walker and Lewis of the causes of the corrosion of metal surfaces that have been painted or varnished. It has been found in practice that in tin cans which have been lacquered inside the corrosion under the influence of acid fruit juices has been much more rapid than in the case of untreated cans. This rapid corrosion takes place at points where the lacquer has been removed by soldering, etc., and is sometimes so pronounced as to cause puncturing of the can in a few weeks. The cause of this has been traced to the depolarizing action of the lacquer itself, coupled with the action of the small proportion of air left in the can. The varnish coating being still unsaturated will absorb hydrogen. The protected surfaces will be thrown into the cathodic state, and the solvent action of the fruit juices will be concentrated at the exposed places. The corrosion will then continue until the air has been consumed and the lacquer has become saturated. In the experiments upon which these conclusions were based two electrodes, one of ordinary iron and the other of lacquered iron, were inserted in the limbs of a V-tube containing potassium chloride solution, and provided with an air-free plug of agar-agar at the bottom. When the electrodes were connected externally a strong reaction for iron was invariably obtained in the limb containing the plain iron, and tests made with Ostwald's bromide voltameter showed that the corrosion was the result of an electric current proceeding through the external circuit from the lacquered iron. To find a complete remedy for the trouble in the case of fruit cans it will be necessary to discover a lacquer impervious to the solution, or, failing that, one that will not act as a hydrogen depolarizer. These results also have an important bearing upon the resistance of metals coated with paint to corrosive influences. The films of paint, etc., exposed to the air finally become completely saturated, but this does not destroy their porous character or prevent the possibility of corrosion at any exposed points due to the depolarizing action of air through the film. This explains the pitting of iron or steel surfaces at places where the paint has peeled off, and also shows the necessity of having the surface of the metal clean before the application of the paint. So long as the film is intact no corrosion of the metal takes place, but the surface beneath the paint appears to become cathodic if an exposed area in its neighborhood can act as an anode. Under the influence of the cathodic liberation of hydrogen the film is gradually detached from the metal, and corrosion of the exposed areas is greatly accelerated.

SCIENCE NOTES.

M. Paul Gaubert finds a new substance which is remarkable for its fluorescence. It is derived from physostigmine. Although the number of fluorescent bodies is considerable, there are few in which the fluorescence is very strong, and none of them can be compared with fluoresceine in this respect. It is therefore of interest to note that the present body has a fine red fluorescence which exceeds that of other known substances. The author observed it during researches he made upon the artificial coloration of crystals. The substance is obtained as follows: An aqueous solution of physostigmine is allowed to stand for several months until it takes a dark blue color. Then the addition of hydrated phthalic acid gives it a blood red color which is due to fluorescence. The production of this tint is a marked characteristic for both these bodies. The crystals of the new body are a dark blue, and other substances are colored by it in dark blue, such as silk, cotton, alcohol and ether, but these do not possess any fluorescence. On the contrary, the water solution is remarkably fluorescent, and even in the case of a drop of dilute solution which is a light bluish hue, when we observe it by reflected light it has a deep red color comparable with that of the ruby.

It was shown some years ago by Mr. Otto Hehner and the present writer that the fat taken from different parts of the same animal varied both in its physical characteristics and chemical composition. Thus, fat from the kidneys of a sheep was found to contain a large proportion of stearic acid, whereas that from the neck of the animal was nearly fluid, and quite free from stearic acid. The proportion of liquid fatty acids in the different fats was approximately measured by what is termed their "iodine values," i. e., the percentage of iodine that they would absorb, and these figures showed equally great variations. The results of a similar investigation on the same lines have recently been published by Messrs. Moulton and Trowbridge, who have examined the fat from different parts of oxen. They find that there is an intimate connection between the amounts of fat and of moisture and protein in the fatty tissue of animals, a high proportion of fat being associated with a low proportion of moisture and protein, and *vice versa*. The proportion of fat in the fatty tissue increases with the fatness of the animal, and that of the moisture with the leanness, so that the condition and not the age is the determining factor. The percentage of fat in the fatty tissue increases from the outside to the inside of the animal, while the moisture shows a decrease. The iodine value (indicating the percentage of liquid unsaturated fatty acids) increases with the age and with the fatness of the animal, whereas the melting point of the fat decreases. A similar increase in the iodine value and decrease in the melting-point may be observed on proceeding from the outside to the inside of the animal, and there is a relationship between the two values, the one rising as the other falls. The specfic gravity of the fat also varies with the iodine value.—Knowledge.

In a paper read before the Geological Society, Dr. W. F. Hume, M.A., F.G.S., superintendent of the Geological Survey of Egypt, divides the fossiliferous cretaceous strata into three series: A northern Antonian type, marked by Cenomanian species, including typical Turonian strata; a central Egyptian or Hammama type with a western chalky limestone indicating a close affinity with the white chalk of northern Europe. A southern or Dungul type, having close affinities with the former, and the fauna consisting of a group of specialized sea-urchins and of gastropods among which Turritellæ are very prominent. Dr. Hume emphasizes the uniformity of the Lower Eocene throughout Egypt, its triple subdivision being recognizable over vast areas. In the Middle Eocene this uniformity is replaced by differentiation, the well-known regions of the Fayûm and the Moqattam Hill differing from the succession in the area selected as typical in his paper. The Cretaceous and Eocene beds differ lithologically, limestones being dominant in the Lower Eocene and shales in the Upper Cretaceous. Palæontologically, great groups such as the Ammonites, still abundant in the Upper Cretaceous, disappear in the Eocene and are replaced by the characteristic nummulinid foraminifera. On the other hand, both periods bear a strong resemblance to each other in the dominance of oysters and sea-urchins over other forms. A notable feature is the comparative rarity of brachiopoda in Egypt throughout both periods, nor have belemnites been recorded from the Egyptian Cretaceous. Among post-Eocene formations the calcareous grits are shown to have a wide extension; but in the desert they differ in character from the mammal-yielding beds of the Fayûm. The cretaceous period in Egypt was therefore one, in the main, marked by the gain of sea over land, the Eocene was one of rest, while at the close of the Eocene and during the Oligocene the approach of a continental phase is clearly indicated.

TRADE NOTES AND FORMULÆ.

Siccative Powder is prepared by mixing 30 parts of lithopone, 30 of zinc-white and 40 of manganese borate. Pass the whole through a fine sieve. This powder is a good drier for white paints.

Protective Paint for Ships' Bottoms.—For two coats (a) red lead 50 parts, white lead 30 parts, litharge 10 parts, oxide of zinc 20 parts, linseed oil 25 parts, oil of turpentine 2.5 parts. (b) Red lead 60 parts, oxide of zinc 30 parts, ocher 10 parts, chloride of mercury 30 parts, linseed oil 25 parts, oil of turpentine 2.5 parts.

To Blacken Iron and Steel.—Gently heat the article and apply a concentrated solution of copper nitrate or manganese nitrate in alcohol. By mixing the two solutions mentioned every desired shade of color between brown-black and blue-black may be obtained. Entirely satisfactory results can only be obtained with articles that have been thoroughly polished and cleaned with benzine.

Heavy Spar Siccative.—This is prepared in the same manner as ocher siccative. A beautiful bright red pigment will be obtained, posessing excellent qualities as a coloring material. When mixed with linseed oil, it will dry in 24 hours. If there is a choice between ocher and heavy-spar, it will be better to work with the latter, as it dries better after precipitation, weighs more, coats better, and has a really beautiful color.

Silver Balls.—Add 2 parts of yellow tripoli to 5 parts of levigated chalk, well mix the two powders and make them into a stiff paste with very weak mucilage (1 part gum arabic to 12 parts of water). The paste may then be rolled with the hand into balls about the size of a pigeon's egg. Place the balls on boards in a moderately hot room to dry, and pack them, when quite solid, in tinfoil. Used for polishing silver.

Cement for Mother of Pearl.—Two parts of isinglass, beaten into small pieces, and soaked twenty-four hours in 16 parts of water, the mass to be then evaporated to half its volume, 8 parts of alcohol added and the mixture strained through linen. While the fluid is still hot, stir in 1 part of mastic dissolved in 6 parts of alcohol, and ½ part of sal-ammoniac, to make an even mixture. In use, the surfaces to be cemented should be warmed before applying the cement. It will harden in five or six hours.

Soap Powder.—Soap powder is prepared from 40 parts calcined potash, 45 parts mountain flax (fibrous gypsum), 10 parts common soap and 10 parts water. Dissolve the soap in water, then add as much as the mass will take up of the mixture of potash and mountain flax. Then add the remaining parts of the potash and mountain flax to the mixture in a tub and place the powder in a drying room till thoroughly dry. Finally sift and pack the powder. It should be borne in mind when packing that the product readily attracts water; also that the packages are liable to burst if they are too full.

Safe Solder.—If equal parts of tin and lead are melted together and the crucible is allowed to cool slowly, a time will arrive before the mixture entirely hardens, when one part congeals to a granular pulp, while another part is still quite liquid. The latter can consequently be poured off if the right moment is not allowed to slip. It is a definite chemical compound of 37 parts of lead and 63 parts of tin, and may be used with advantage as a rapid solder on account of its special fluidity. It need hardly be mentioned, however, that the same mixture can be prepared by simply mixing the metals in the given proportions.

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